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TYPES

OF THE

LARAMIE FLORA

BY

LESTER F. WARD

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TYPES OF THE LARAMIE FLORA.

By Lester F. Ward.

EXPLANATORY REMARKS.

I have in preparation a work on the flora of the Laramie group, in which will be described and figured a very large number of fossil plants, most of which were collected by myself in the seasons of 1881 and 1883 and the elaboration of which has occupied most of my time since the latter date. The work of illustrating this material has progressed slowly and cannot be completed earlier than the end of the present year (1887), after which much will still remain to be done before the volume can be ready for publication. Realizing this, and also the fact that the illustrated monographs of the Geological Survey are usually long delayed in printing, and feeling the importance of making known the general character of these additions to the Laramie flora at an earlier date, I thought best to prepare and publish as a preliminary sketch some of the more striking types from among the collections. Accordingly, in July, 1885, there were submitted for publication in the Sixth Annual Report of the Survey, at the close of my paper entitled "Synopsis of the Flora of the Laramie Group," thirty-five double plates, containing one hundred and thirty-nine figures, accompanied by a list of the provisional names which my studies up to that time had enabled me to assign.

In that paper, a portion of which was devoted to a description of the localities at which the material was collected, it was explained that the selections were not made altogether from the best or most instructive specimens, but consisted rather of the more representative types of such as were then ready, and that it was expected that further research would elucidate many obscure points and suggest important modifications.

It was no part of my purpose in that paper to furnish descriptions of the species regarded as new and lack of space debarred me from introducing critical comments upon any of the forms figured. As, however, such descriptions and discussions are necessary to the proper understanding of the figures and of the nature of the flora under treat-

ment, I commenced to characterize these forms on my return from the field in September, 1885, and to append such explanatory notes as were necessary to render this part of the work intelligible and available to scientific men. The present bulletin is the result. I had originally intended to publish it merely as a text to the figures in the Sixth Annual Report, but it was finally decided to rearrange the figures on plates of smaller size, adapted to the bulletins, and thus render the work complete in itself.

No changes have been made in the names given to the species in the previous paper, but wherever, as has sometimes occurred, later investigations have led me to modified conclusions relative to the proper affinities of the forms described, the changes thus proposed are mentioned in the discussions.

The following table will show the corresponding figures in the two sets of plates:

Table to facilitate cross-reference between the plates and figures in this bulletin and the same figures as published in the Sixth Annual Report of the U. S. Geological Survey, Plates XXXI to LXV.

Bulletin.		Annual Report.		Bulletin.		Annual Report.		Bulletin.		Annual Report.	
Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.
I	1	XXXI	1	V	1	XXXIII	8	IX	1	XXXVI	6
	2		2		2		9		2		7
	3		3		3		11		3		8
	4		4		4	XXXIV	1		4		9
	5		5		5		2		5		10
	6		6		6		3		6	XXXVII	1
II	1		7		7		4	X	1		2
	2		8	VI	1		5		2		3
	3		9		2		6		3		4
	4		10		3		7		4		5
	5		11		4		8		5		6
	6		12		5		9		6		7
III	1	XXXII	3		6	XXXV	1		7		8
	2		1		7		2		8		9
	3		2		8		3	XI	1		10
	4		4	VII	1		4		2		11
	5		5		2		5		3	XXXVIII	1
	6		6		3		6		4		2
	7		7		4		7		5		3
IV	1	XXXIII	1		5		8	XII	1		4
	2		2		6		9		2		5
	3		3	VIII	1		10	XIII	1	XXXIX	1
	3a		3a		2		11		2		2
	4		4		3	XXXVI	1		3		3
	5		5		4		2		4		4
	6		6		5		3		5		5
	7		7		6		4		6		6
	8		10		7		5		7		7

Table to facilitate cross-reference between plates and figures in this bulletin, &c.—Cont'd.

Bulletin.		Annual Report.		Bulletin.		Annual Report.		Bulletin.		Annual Report.	
Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.
XIV	1	XXXIX	8	XXV	3	XLVII	6	XXXIII	6	LII	2
	2	XL	1		4		7		7		3
	3		2		5		8		8		4
	4		3	XXVI	1	XLVIII	1		9		5
	5		4		2		2		10		6
	6		5		3		3		11		7
XV	1		6		4		4		12		8
	2		7		5		5		13		9
	3		8		6		6		14		10
	4		9		7		7	XXXIV	1		11
XVI	1	XLI	1	XXVII	1		8		2		12
XVII	1	XLII	1		2		9		3		13
XVIII	1		2		3		10		4		14
	2		3		4		11		5		15
	3		4		5		12		6		16
	3a		4a	XXVIII	1	XLIX	1	XXXV	1	LIII	1
XIX	1	XLIII	1		2		2		2		2
XX	1	XLIV	1		3		3		3		3
	2		2		4		4		4		4
	3		3		5		5		5		5
	4		4	XXIX	1		6		6		6
	5		5		2		7	XXXVI	1		7
XXI	1		6		3		8		2		8
	2		7		4		9		3		9
	3	XLV	1		5	L	1		4		10
XXII	1		2	XXX	1		3	XXXVII	1	LIV	1
	2		3		2		2		2		2
	3		4		3		4		3		3
	4		5		4		5		4		4
	5		6		5		6		5		5
	6		7	XXXI	1		7	XXXVIII	1		6
	7		8		2		8		2		7
	8		9		3		9		3		8
XXIII	1	XLVI	1		4		10		4		9
	2		2		5	LI	1		5		10
	3		3		6		2		6		11
	4		4		7		3		7		12
	5		5	XXXII	1		4	XXXIX	1		13
	6		6		2		5		2		14
	7		7		3		6		3	LV	1
	8		8		4		7		4		2
	9		9		5		8		5		3
	10		10		6		9		6		4
XXIV	1		11		7		10		7		5
	2		12		8		11	XL	1		6
	3	XLVII	1	XXXIII	1		12		2		7
	4		2		2		13		3		8
	5		3		3		14		4		9
XXV	1		4		4		15		5		10
	2		5		5	LII	1	XLI	1	LVI	1

Table to facilitate cross-reference between plates and figures in this bulletin, &c.—Cont'd.

Bulletin.		Annual Report.		Bulletin.		Annual Report.		Bulletin.		Annual Report.	
Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.	Plate.	Fig.
XLI	2	LVI	2	XLVIII	4	LX	3	LIII	6	LXIII	4
	3		3	XLIX	1		4	LIV	1		5
	4		4		2		5		2		6
	5		5		3		6		3		7
	6		6		4		7		4		8
XLII	1		7		5		8		5		9
	2		8	L	1	LXI	1	LV	1	LXIV	1
	3		9		2		7		2		2
	4	LVII	1		3		3		3		3
XLIII	1		2	LI	1		2		4		4
	2		3		2		4		5		5
	3		4		3	LXII	1		6		6
XLIV	1		5		4		2		7		7
	2	LVIII	1		5		3		8		8
	3		2		6		4		9		9
XLV	1		3		7		5	LVI	1		10
	2		4		8		6		2		11
	3		5	LII	1	LXI	6		3		12
XLVI	1		6		2		5		4	LXV	1
XLVII	1	LIX	1		3	LXII	7		5		2
	2		2		4		8		6		3
	3		3	LIII	1		9	LVII	1		4
	4		4		2		10		2		5
XLVIII	1		5		3	LXIII	1		3		6
	2	LX	1		4		2		4		7
	3		2		5		3		5		8

DESCRIPTION OF THE SPECIES.

CRYPTOGAMS.

ALGÆ.

FUCUS L.

This genus as now restricted is almost exclusively confined to the northern hemisphere, the sea-weeds of the southern hemisphere going by different names. It is a tidal form and not found in deep water. About a dozen species are known, which, however, gives no idea of their vast abundance upon the rocky shores where they grow. They are mostly high northern, and the greater part of the species are common to both the Old and the New World. Until recently the only fossil species recognized were those described by Watelet from the Paris Basin, six of which were considered sufficiently reliable to be accepted by Schimper in his Paléontologie végétale. Since the appearance of the latter work Heer has detected the remains of one of the living species (*F. caniculatus* L.) in the Quaternary deposits of Spitzbergen. Lesquereux and myself have found the species mentioned below in two different localities belonging to the Laramie group, and Pilar thinks he recognizes two species of Fucus in the Miocene deposits of Sused.

Fucus lignitum Lx.

FUCUS LIGNITUM Lx., Bulletin U. S. Geol. Survey of the Territories, Vol. I, No. 5, p. 364; Annual Report do., 1874, p. 296; Tert. Fl., p. 42, pl. lxi, figs. 24, 24*a*.

Plate I, Figs. 1, 2. — Point of Rocks, Wyoming; white sandstone bed east of station (Fig. 1). Burns's Ranch, Montana (Fig. 2).

The specimen represented by Fig. 1 comes from the same bed at Point of Rocks as that collected by Dr. F. V. Hayden and figured by Prof. Leo Lesquereux. It is a somewhat fuller specimen and shows more of the branches. The other specimen (Fig. 2) was found at Burns's Ranch, on the Yellowstone, and has already been referred to as part of the evidence of partial synchronism of the two beds. Though an inferior specimen it seems to belong to the same species. Prof. Lesquereux refers to its resemblance to *Sphærococcites crispiformis* Schloth.; and *S. Schambelinus* Heer (Urwelt der Schweiz, pl. iv, fig. 1) may also be profitably compared. In its external character, at least, it closely resembles forms of Gelidium (see Saporta, Algues Fossiles, pl. iii, figs. 1*b*, 3), and also some forms of Chondrites.

SPIRAXIS Newberry.

A genus recently created, as mentioned below. It seems to be one of the ancient forms of fossil kelp, the more recent representatives of which go by the name of Halymenites.

Spiraxis bivalvis, n. sp.

Plate I, Fig. 3.—Head of Clear Creek, Montana.

Body cylindrical or fusiform, often tapering toward both ends, traversed by numerous fine spiral ridges at an angle of 60° to the axis, slightly verrucose, minutely fistulose at the center, cleft through longitudinally by a plane that generally passes a little to one side of the center and is either strictly tangential or slightly curved, the larger segment often cleft also through its center, or sometimes the cylinder divided by three planes of cleavage into three nearly equal segments uniting at the center.

This is the peculiar fucoid found near the head of Clear Creek, to which reference was made when treating of that locality. It certainly bears a strong general resemblance to some of the "screw-like fossils from the Chemung rocks" recently made known by Dr. J. S. Newberry (Annals N. Y. Acad. Sciences, Vol. III, pp. 217–220, pl. xviii) under the name of Spiraxis, and although his specimens came from a very much lower horizon his theory of their fucoidal character is doubtless correct and the present specimens from the Fort Union group probably belong to the same form of life. I have therefore ventured to refer them to the same genus, although this may extend its geological range more widely than the author intended.

The specific name is based upon the tendency, already referred to, which this particular form exhibits, to split into two valves or halves by a longitudinal cleavage which passes across the spiral striæ upon the surface without being in the least affected by them.

PHANEROGAMS.

GYMNOSPERMS.

CONIFERÆ.

GINKGO L.

The sole living representative of this once abundant genus is thought to have been confined to China prior to the advent of man, but now it is not only widely distributed throughout eastern Asia and Japan, but also throughout the western world as an ornamental tree. In the fossil

state it ranges from the Permian to the Miocene. Two of the twenty-five fossil species have already been described from the Laramie group, to which two more are here added.

Ginkgo Laramiensis Ward.

GINKGO LARAMIENSIS Ward, Science, Vol. V, June 19, 1885, p. 496, fig. 7.

Plate I, Fig. 4.—Point of Rocks, Wyoming; gray sandstone bed north of station.

Leaves small (3 to 5 cm. in width), narrowed to the petiole, the margin undulate, sinuate, or somewhat lobate; nerves flabellate-divergent, many times dichotomous.

The occurrence of sinuses of variable depth at irregular intervals around the margins of the leaves is the chief distinction which separates this form from both *G. adiantoides* and *G. biloba*, between which it clearly holds an intermediate position.

Twelve fragments of this leaf were collected at Point of Rocks in the sandstone bed north of the station, the one figured here being perhaps the most perfect. At the request of Dr. Newberry, who saw them at the National Museum, they were sent to him at the School of Mines, New York, and subsequently returned by him with the remark that he could find no sufficient characters to justify a specific distinction between them and leaves of the living species, *G. biloba*. There certainly is very little difference, except in size, but between *G. adiantoides* Ung. and the living species there is not even that difference. I have therefore thought best to commemorate this small form by a separate name and retain Unger's name for the next. Should intermediate forms be subsequently discovered, all might perhaps be referred to *G. biloba*.

Ginkgo adiantoides (Ung.) Heer.

GINKGO ADIANTOIDES (Ung.) Heer, Fl. Foss. Arct., Vol. V, Pt. III (Prim. Fl. Foss. Sachal.), p. 21, pl. ii, figs. 7-10.

SALISBURIA ADIANTOIDES Ung., Synops., p. 211; Gen. et Spec., p. 392. Massal. & Scarab., Fl. Foss. del Senigal., p. 163, pl. i, fig. 1; pl. vi, fig. 18; pl. vii, fig. 2. Heer, Fl. Foss. Arct., Vol. I, p. 183, pl. xlvii, fig. 14; Vol. II, Pt. IV (Foss. Fl. N. Greenland), p. 465, pl. xliv, fig. 1.

Plate I, Figs. 5, 6.—Seven Mile Creek, Montana; Sparganium bed.

The discovery of these interesting leaf impressions in the Sparganium bed at Seven Mile Creek was mentioned in the Sixth Annual Report (p. 545). They have nearly the size of the leaves of the living species and do not appreciably differ from the non-lobate forms of it which frequently occur (some trees having nearly all their leaves without lobes and others having them nearly all lobed). The lobes also differ greatly in depth and the Fort Union leaves sometimes have shallow sinuses.

SEQUOIA Endl.

Like Ginkgo, this genus represents a waning type of plant life, only the two well known Californian species remaining of the forty or more that are described in the fossil state. These latter range from the base of the Cretaceous, or even from the upper Jurassic, to the Pliocene. Six belong to the Laramie group, of which two are from the northern districts.

Sequoia biformis Lx.

SEQUOIA BIFORMIS Lx., Bulletin U. S. Geol. Surv. Terr., Vol. I, p. 366; Ann. Rep. do., 1874, p. 298; Tert. Fl., p. 80, pl. lxii, figs. 15–18, 18*a*.

Plate II, Figs. 1–6.—Point of Rocks, Wyoming; white sandstone bed east of station (Figs. 1, 2); white marl bed northwest of station (Figs. 3, 6).

The two specimens, Figs. 1 and 2, are from the original fine white sandstone bed at Point of Rocks, long since explored by Dr. Hayden and Mr. William Cleburne; but they differ from the specimens collected by Hayden and figured by Lesquereux in having the shorter leaves more densely packed together and especially in exhibiting rhombic scars at the points where the leaves have fallen away. In this latter character they resemble more closely the forms called Araucarites. I do not, however, consider it probable that my specimens from that bed represent a different species from that formerly collected there, and the differences are probably due to accidents of preservation.

The special interest attaching to them is in the fact that all the other specimens, which agree more closely with those formerly collected, come from the white arenaceous marl bed at the base of the cliff to the northwest of the station. They greatly strengthen the presumption which I entertained at that time that these beds might be the equivalent of the others and be in their observed position by virtue of either a strong westerly dip or a fault in the intermediate region. It is important to know this, since by such knowledge the relative position of the more important bed, some 300 feet almost directly over this one, could be determined.

ANGIOSPERMS.

MONOCOTYLEDONS.

GRAMINEÆ.

PHRAGMITES Trin.

The two living species of Phragmites are very widely diffused throughout temperate and tropical regions of the globe. Four or five times as many species are described in the fossil state, chiefly from the Miocene; but three are found in Laramie strata. The reference of some of these forms to this genus is very doubtful.

Phragmites Alaskana Heer.

PHRAGMITES ALASKANA Heer, Fl. Foss. Arct., Vol. II, Pt. II (Fl. Foss. Alask.), p. 24, pl. i, figs. 12, 12 *b*. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1871, p. 296; Tert. Fl., p. 90, pl. viii, figs. 10–12, 12*a*; Cret. and Tert. Fl., p. 141. Schimper, Pal. Vég., Vol. II, p. 398.

Plate III, Figs. 1–3.— Burns's Ranch, Montana.

There can be no doubt that these specimens represent the same plant that is figured by Lesquereux (Tert. Fl., pl. viii, fig. 10), collected 6 miles above Spring Cañon, near Fort Ellis, Mont., and it is a form that seems to be confined to the Fort Union group. It is probably not Phragmites, and may be profitably compared with *Bambusa Lugdunensis*. (See Saporta, Vég. Foss. de Meximieux, pl. xxiii, figs. 8–16.)

LEMNACEÆ.

LEMNA L.

Seven species of this genus are found inhabiting the fresh waters of temperate and tropical parts of the world. Besides the one named below, only two species are known in the fossil state. One of these is from the Green River shales at Florissant, Colo.

Lemna scutata Dawson.

LEMNA SCUTATA Dawson, Report on the Geology of the 49th Parallel, Appendix A, p. 329, pl. xvi, figs. 5, 6; Trans. Roy. Soc. Can., Sec. IV, 1882, p. 32. Lesquereux, Ann. Rep. Geol. Surv. Terr., 1874, p. 300; Tert. Fl., p. 102, pl. lxi, figs. 2–5.

Plate III, Figs. 4, 5.—Burns's Ranch, Montana.

I have concluded to refer these forms to *Lemna scutata* rather than to *Pistia corrugata* because none of them have the obovate shape characteristic of the mature leaves found at Point of Rocks and because, if there is any difference between the Point of Rocks specimens and those from British America, the probabilities are in favor of the identity of our plant with the latter, which doubtless belongs to the Fort Union group. But I quite agree with Prof. Lesquereux that the two are one and that all the specimens from Point of Rocks beds, which I also carefully examined while there, belong to a single species. All the specimens figured are from Burns's Ranch, but faint impressions (showing no nervation) of what I have little doubt is the same plant are visible upon some of the Iron Bluff shales.

TYPHACEÆ.

SPARGANIUM L.

This is rather a northern type occupying temperate and subfrigid regions, but representatives are found in Australia. There are in all half a dozen living species and about ten fossil ones, of which *S. Stygium* Heer is by far the best known.

Sparganium Stygium Heer.

SPARGANIUM STYGIUM Heer, Fl. Tert. Helv., Vol. I, p. 101, pl. xlv, figs. 1–4; Fl. Foss. Arct., Vol. I, p. 97, pl. xlv, figs. 2*a*, 13*d*; Vol. II, Pt. IV (Foss. Fl. N. Greenland), p. 467, pl. xliii, figs. 4*b*, 5, 5*b*. Schimper, Pal. Vég., Vol. II, p. 473.

Plate III, Figs. 6, 7.—Seven Mile Creek, Montana.

The single heads, which occur in masses on the rocks of the next highest beds of the Seven Mile Creek series, agree almost absolutely with the one figured by Heer in the Arctic Flora last cited, and this alone has determined me to refer our plant to that species. But the special interest in the case is the occurrence of about complete racemes, bearing single heads at the extremities of pedunncles nearly an inch long. Two such racemes were obtained, one of which is figured (Fig. 7). These heads are smaller than those found separate and the fruits are less acuminate. I presume they represent an earlier stage in the development of the plant. At least, as all were found at one place, there seems no good reason for supposing that they represent two species.

DICOTYLEDONS.

APETALÆ.

SALICINEÆ.

POPULUS L.

The Fort Union group seems to be exceedingly rich in forms of Populus, which are probably the ancestors of the forms that still constitute almost the only arboreous vegetation of the region embraced by that extensive deposit. But it is remarkable, if such be the case, that the existing forms, *P. monilifera*, *P. balsamifera* (with its willow shaped variety, *angustifolia*) and also, to some extent, *P. tremuloides* have a much more pinnate nervation, and where tending to be palmate it never possesses the decidedly acrodrome character which belongs to nearly all the fossil forms, not only of western America but of the Arctic regions. It is only in the fossil floras of Europe that the pinnately nerved forms occur (cf. *P. latior*, *P. balsamoides*). It would seem that the Old World forms, after having been distributed over both hemispheres, proved fittest to survive in the struggle for existence with glacial agencies.

Dr. Newberry, in his Later Extinct Floras of North America, describes eight species of Populus from the Fort Union group, and in the great profusion of forms which I found, and which are represented so abundantly in my collections, I certainly expected that the most of those figured by him would be represented. But, unless we allow a much greater range of variation both in general form and in nervation than

ever occurs with living species, only one of his species can be with certainty identified in my collections, and only two of my forms can, without such undue expansion of the characters, be referred to any species hitherto described. On the other hand, there are some eight or ten forms which, after examining all the species of Populus, both fossil and living, to which I have access through either specimens or figures, I am compelled to record as new and distinct from one another. It is true that great liberty has been taken by certain authors in referring forms differing entirely in their nervation to the same species, but if they have examined living specimens they must have found that they agree in nervation even where they differ in nearly all other respects.

Populus glandulifera Heer.

POPULUS GLANDULIFERA Heer, Fl. Tert. Helv., Vol. II, p. 17, pl. lviii, figs. 5–11; pl. lxiii, fig. 7; Fl. Foss. Arct., Vol. II, Pt. II (Fl. Foss. Alask.), p. 26, pl. ii, figs. 1, 2; Vol. V, Pt. III (Prim. Fl. Foss Sachal.), p. 25, pl. iii, fig. 4; Pt. IV (Mioc. Pfl. v. Sachal.), p. 5, pl. ii, figs. 7*a*, *b*; Fl. Foss. du Portugal, p. 25, pl. xxi, figs. 5, 6*a*. Ludwig, Palæontogr., Vol. VIII, p. 91, pl. xxvi, fig. 10. Schimper, Pal. Vég., Vol. II, p. 690. Lesquereux, Cret. and Tert. Fl., p. 226, pl. xlviA, figs. 3, 4.

Plate IV, Figs. 1–4, Fig. 3*a* enlarged.—Burns's Ranch, Montana.

The forms referred to this species are all alike in nervation and in form and all come from the carbonaceous shale at Burns's Ranch, where the fine grained character of the rock brings out the nervation in a very perfect manner. They do not agree well enough with the originals figured by Heer (Fl. Tert. Helv., pl. lviii) to have suggested their identity, but they are substantially identical with the forms figured by Lesquereux from the Bad Lands of Dakota (belonging to the Fort Union group), in his Cretaceous and Tertiary Floras (pl. xlviA, figs. 3, 4), Fig. 2 agreeing entirely with his fig. 4. The rest of the specimens have a somewhat more irregular outline, but this and all other peculiarities are seen in Heer's fig. 7, pl. lxiii, of the Tertiary Flora of Switzerland, quoted above. Baron von Ettingshausen, to whom the figures have been sent, regards this as a distinct species.

Populus cuneata Newberry.

POPULUS CUNEATA Newberry, Later Extinct Floras, pp. 31, 64; Illustr. of Cret. and Tert. Plants, pl. xiv, figs. 1–4. Lesquereux, Cret. and Tert. Fl., p. 225, pl. xlviA, fig. 5. Dawson, Cret. and Tert. Fl. Brit. Col. and N. W. Terr., Trans. Roy. Soc. Can., Sec. IV, 1882, p. 32.

Plate IV, Figs. 5–8; Plate V, Figs. 1–3.—Seven Mile Creek, Montana, Sparganium bed (Plate IV, Figs. 5–8; Plate V, Figs. 1, 2). Clear Creek, Montana (Plate V, Fig. 3).

All but the last of the specimens of this form figured here came from the Sparganium bed of the Seven Mile Creek system and are perfectly normal in all respects; the last (Plate V, Fig. 3) presents some differences and was collected at Clear Creek. It may be a form of *Populus arctica* Heer and has its nearest analogue in the specimen from Siberia

figured by Heer in the Arctic Flora (Vol. V, Pt. II, Foss. Fl. Sibir., pl. xv, fig. 3). The species occurred at Cracker Box Creek and in other beds, but the specimens are less perfect.

Populus speciosa, n. sp.

Plate V, Figs. 4-7.—Clear Creek, Montana.

Leaves long petioled, 5 to 7cm. wide, the blade but little longer, rounded sinuate or crenate except the nearly horizontal base, palmately nerved; midrib strong, lateral primaries three pairs, all uniting with the midrib at the summit of the petiole, the innermost pair much the strongest, acrodrome, outer pair basal and delicate; tertiary nerves distinct, often terminating directly in the blunt teeth, frequently anastomosing and forming arches from which finer ones proceed to the margin.

These fine specimens from the Clear Creek beds probably most closely resemble *P. arctica* Heer, but there are some constant differences, such as the rounded teeth, which seem to be essential. It is also a larger and in every way handsomer form. The five principal nerves always unite at the summit of the petiole, and in most of the specimens the base is nearly or quite horizontal without being cordate.

Populus amblyrhyncha, n. sp.

Plate VI, Figs. 1-8; Plate VII, Figs. 1-3.—Seven Mile Creek, Montana; white marl bed.

Leaves long petioled, 3.5 to 8.5cm. broad, the blade considerably longer than broad, varying from cordate to wedge shaped at the base, entire to near the widest part, rounded sinuate or crenate above, somewhat irregular in outline, the apex prolonged into a blunt point; midrib strong; lateral nerves one to three pairs, the inner pair much the strongest, uniting with the midrib some distance above the summit of the petiole, somewhat alternate, erect, sending out strong tertiaries which branch and anastomose, sometimes reaching the margin and terminating in blunt teeth which project beyond the others; lower lateral primaries light, alternate, or of unequal number on the two sides of the midrib; nervilles faint, percurrent or broken.

These constant forms are all from one bed, viz, the highest at Seven Mile Creek, and seem distinct from all others I have examined. They all agree in having the two or three principal nerves unite with the midrib a short distance above the base of the leaf, below which the thin basilar nerves proceed. The rounded teeth are somewhat irregular toward the summit, and the terminal one is usually produced into a conspicuous blunt snout, which gives a distinct character to this species and from which I have given it its name.

Populus daphnogenoides, n. sp.

Plate VII, Figs. 4-6.—Seven Mile Creek, Montana; white marl bed.

Leaves ovate in outline, entire near the wedge shaped base, rounded-sinuate or somewhat sharply toothed above, terminating in a long, en-

tire, often curved, blunt point; petiole divided a little above the base of the blade into three strong, nearly equal, primary nerves, the two lateral ones distinctly acrodrome and very erect, terminating near the apex, giving off strong tertiaries which branch and terminate in the teeth; basal nerves light or indistinguishable; nervilles irregular, branched, often percurrent.

In searching for the analogues of this form they are chiefly found, so far as the size, shape, and general nervation are concerned, among other genera than Populus, for example, Zizyphus, Paliurus, Daphnogene, and Cinnamomum, but upon closer scrutiny they fail to convince me that these leaves are not those of a true Populus and one not widely distinct from that last mentioned, from which they differ in their smaller size, more narrowed and elongated form, and in having somewhat sharper teeth.

Populus oxyrhyncha, n. sp.

Plate VIII, Figs. 1, 2. - Seven Mile Creek, Montana; white marl bed.

Leaves broader than long, 4.5 to 6cm. in width, entire or slightly undulate to the middle, irregularly rounded-dentate and somewhat three-lobed above, terminating in an acute or slightly obtuse point, horizontal or slightly wedge shaped at the base; palmately nerved, the inner lateral primaries nearly equaling the midrib, erect and curving inward, giving off strong tertiaries from near the base which often reach the margin, uniting near the summit with tertiaries from the midrib; nervilles distinct, flexed in the middle and united by others running parallel to the tertiaries, forming quadrate or trapezoidal meshes.

I at first thought it would be necessary to separate these two forms, but upon further study I conclude to unite them. They have some resemblance to the specimens which I have designated as *P. amblyrhyncha*, but the mode of union of the primary nerves with the midrib is different and one of the specimens (Fig. 2) has the point decidedly acute. This resembles in general character Unger's figure of *P. attenuata* Al. Br., published in his Sylloge (III, pl. xxii, fig. 15), but there the lateral primaries rise from some distance above the base of the leaf and send out secondaries in a very different manner.

The other specimen (Fig. 1) resembles very closely Saporta's *P. Euboica* (Monde des Plantes, p. 285, fig. 80, No. 1), but is considerably larger. It differs from most of the other specimens from this locality in exhibiting a much larger amount of detailed nervation, but whether this indicates a leaf of different texture or merely an accident of preservation it is impossible to say.

Populus craspedodroma, n. sp.

Plate VIII, Fig. 3.—Burns's Ranch, Montana.

Leaf small for the genus, ovate in outline, somewhat lobed, heart shaped, toothed all round, the teeth prominent, unequal,

or rounded, the terminal tooth prolonged; nervation craspedodrome; midrib much stronger than the lateral nerves, these in two pairs rising from the summit of the petiole, the basal pair very light, terminating in the first teeth, second pair proceeding from the midrib at an angle of 60° to the margin at the widest part of the leaf and terminating in a strong tooth or lobe, the upper pair strongest, erect, and dichotomously branching, the ultimate ramifications ending in the teeth; nervilles few and faint, often ending blind, forming near the midrib irregular meshes.

It is with grave doubts that I refer this beautiful impression to the genus Populus rather than to Hedera or Vitis. It has, however, all the essential characters of the genus, even to the basilar nerves, and yet the principal nerves pass directly into the teeth, which have the peculiar narrow but blunt form characteristic of the Vitaceæ.

Populus Whitei, n. sp.

Plate VIII, Fig. 4.—Burns's Ranch, Montana; collected by Dr. C. A. White in 1882 and named in his honor.

Leaf long petioled, subrhombic in outline, three lobed, unequally toothed to near the base, terminating in a prominent, slightly recurved point; nervation craspedodrome; lateral primary nerves in two pairs, upper pair nearly equal to the midrib, arising from above the base of the blade, erect and acrodrome, sending out strong secondary nerves to the lobes and teeth; lower pair short, rising midway between these and the base; nervilles percurrent, more or less curved, flexed in the middle, sometimes forking.

This specimen occurs in the collection of Dr. C. A. White from the lower Yellowstone district, made in 1882, and was collected at Burns's Ranch. My collection from that locality contains nothing that resembles it, unless the species last named may be said to do so. For a long time I supposed this form to be the same as that figured by Newberry on plate xiii, fig. 5, of the Illustrations of Cretaceous and Tertiary Plants, under the name of *Populus acerifolia*, although that figure bears almost no resemblance to the others under the same name. But a careful comparison convinces me that the two forms are distinct, and the strongly craspedodrome character of the nervation makes it somewhat doubtful whether our specimen represents a true Populus.

Populus hederoides, n. sp.

Plate VIII, Fig. 5.—Seven Mile Creek, Montana; white marl bed.

Leaf long petioled, large, (7.5cm. wide), coarsely sinuate-toothed to belowthe middle, entire at the base; midrib flexuous, divided at considerable distance above the base of the blade into three equal branches, the lateral branches curving upward and inward toward the apex and giving off three or four secondaries, which go to the margin; lower pair of lateral primary nerves arising from a point lower down and near

the base, light, simple, and parallel to the margin, terminating in the first or second tooth; nervilles faint, straight, percurrent.

That this impression represents a true Populus I am quite certain, although the nervation is wholly anomalous and the general form more nearly approaches some species of Hedera. Only one specimen accompanies the collection, and of this the summit is wanting. It is from the highest beds of the Seven Mile Creek series.

Populus Richardsoni Heer.

POPULUS RICHARDSONI Heer, Fl. Foss. Arct., Vol. I, p. 98, pl. iv, figs. 1–5, 6*b*; pl. vi, figs. 7, 8; pl. xv, fig. 1*c*; p. 137, pl. xxiii, figs. 2*a*, 3; p. 158, pl. xxxi, figs. 1*a*, 2; Vol. II, Pt. III (Mioc. Fl. Spitzbergens), p. 54, pl. x, figs. 8–12; Pt. IV (Foss. Fl. N. Greenland), p. 468, pl. xliv, figs. 7, 8, 9*a*; pl. lv, fig. 3*b*; Vol. IV, Pt. I (Foss. Fl. Spitzbergens), p. 68, pl. xi, fig, 7*c*; pl. xiv, fig. 4; pl. xxxii, figs. 1, 2; Vol. V, Pt. II (Foss. Fl. Sibiriens), p. 49, pl. xv, fig. 7. Lesquereux, Tert. Fl., p. 177, pl. xxii, figs. 10–12. Schimper, Pal. Vég., Vol. II, p. 688.

Plate VIII, Fig. 6.—Burns's Ranch, Montana.

Although only a single fragment, this specimen differs from all the rest in the collections and agrees in all respects with the characters of *P. Richardsoni*. I have therefore no alternative but to refer it to that species.

Populus anomala, n. sp.

Plate VIII, Fig. 7.—Burns's Ranch, Montana.

Leaf long petioled (4cm.), 4.5cm. wide, roundish-ovate, strongly and somewhat sharply toothed to below the middle, entire and rounded at the base; nervation pinnate, craspedodrome; midrib thick, dichotomous above; secondaries two or three on each side below the forks of the midrib, strong, parallel to one another, curving upward, the upper forking, the lower giving off tertiaries from the under side; nervilles distinct, close together, somewhat curved, mostly percurrent, often bent in the middle, forked or joined by cross nerves.

This very anomalous form, of which the immediate base and the summit are unfortunately wanting, accompanied Dr. White's collection from Burns's Ranch and was not duplicated by my researches. The form is somewhat similar to that of *Populus subrotundata* Lx. (Tert. Fl., pl. xxiv, figs. 6–8), but the nervation is more pinnate and craspedodrome. Its place may be in another genus, but the petiole, which is long and preserved entire, is that of a Populus.

Populus Grewiopsis, n. sp.

Plate IX, Fig. 1.—Seven Mile Creek, Montana; white marl bed.

Leaf large (8cm. broad), long petioled (6cm.), roundish in outline, toothed to near the base, teeth unequal, obtuse or acute; nervation subpalmate, craspedodrome; midrib strong and straight, passing through the center of the leaf; lateral nerves 6 to 8 on each side, alternate, the

lowest basilar and slight, the third above the base on each side much the strongest, all except the lowest nearly straight, terminating in the teeth and giving off tertiaries that pass directly to other teeth; nervilles few, straight, percurrent, at right angles to the nerves.

I was long undecided whether to refer this nearly perfect and very distinct impression to Populus, Viburnum, or Grewiopsis. To some specimens which I refer to the last named of these genera it has a decided resemblance (cf. *infra*, pp. 89–90, Pl. XL, Figs. 2–5). But the very well marked basilar nerves seem to decide the case, and the plant resembles quite closely the part that is shown of one of Heer's figures of *Populus Richardsoni* (Fl. Foss. Arct., Vol. IV, Pt. I, Foss. Fl. Spitzbergens, pl. xiv, fig. 4). The long petiole is also that of a Populus, and here we will leave it, for the present at least.

The specific name should be written with a capital initial to indicate its affinities with Grewiopsis and not with Grewia.

Populus inæqualis, n. sp.

Plate IX, Fig. 2.—Burns's Ranch, Montana.

Leaf roundish in outline, sharply and irregularly toothed above the middle, entire or undulate-margined below, abruptly narrowed at the uneven base to the distinctly wing-margined petiole; nervation pinnate, mixed (craspedo camptodrome); midrib far to one side, curved, forked near the summit; secondary nerves six on each side, nearly equally prominent except the one or two lowest, passing out to near the margin, where they fork or are joined by arches, the ultimate ramifications proceeding into the teeth; nervilles few and irregular, forking or joined.

This is perhaps the most anomalous form of all, but there is less doubt than in some of the previous cases as to its generic affinities. Its sharp teeth turned forward, pinnate nervation, numerous secondaries, and general asymmetry distinguish it from all the forms I have been able to compare with it.

CUPULIFERÆ.

QUERCUS L.

Very few forms clearly referable to Quercus occur in the collections, and these come chiefly from the lower districts. The only one figured here from the Fort Union group is of doubtful generic affinity.

Quercus bicornis, n. sp.

Plate IX, Fig. 3.—Seven Mile Creek, Montana; bed below the ironstone.

Leaf obovate-oblong, 2.6cm. broad, 6.5cm. long inclusive of the petiole which is 1.5cm. long, entire below, tricuspidate at the summit, the terminal cusp long and recurved, the two lateral shorter, unequal,

sharp, and curved inward, separated from the terminal by rounded sinuses; nervation pinnate; midrib straight, except the curved summit; secondaries numerous (about twelve on each side) and hence close together, subopposite, proceeding from the midrib at an angle of 40° to 50°, curving upward near the margin, to which they become tangential, nearly simple, two of them running out into the tips of the cusps, otherwise camptodrome, one on each side forking and striding the sinuses; nervilles faint, percurrent, at right angles to the secondaries.

I have been unable to find anything with which the leaf can be compared. Distant resemblances may be seen in *Quercus troglodytes* (Fl. Foss. Arct., Vol. VI, Abth. II, Foss. Fl. Grönld., pl. xxix, fig. 14), *Q. Mediterranea* Ung., and *Q. Zoroastri* Ung. (Foss. Fl. v. Kumi, Denkschr. Wien. Akad., Vol. XXVII, pl. vi, figs. 1–28), as well as in some living species, as, for example, *Q. Ilex* (cf. Saporta, Vég. Foss. be Meximieux, pl. xxiv, fig. *a*). Analogues also occur in other genera (cf. *Myrica latiloba acutiloba* Lx., Tert. Fl., pl. xvii, fig. 13), and the specimen, though nearly perfect, is doubtfully referred to Quercus.

Quercus Doljensis Pilar.

QUERCUS DOLJENSIS Pilar, Flora fossilis Susedana, p. 37, pl. vii, fig. 14.

Plate IX, Figs. 4, 5.—Black Buttes Station, Wyoming.

The remarkable similarity of form and nervation between these specimens and those figured by Pilar from Dolje in Sused justify their reference to that species, notwithstanding the improbability that the same species should flourish in the American Laramie and the Miocene of southeastern Europe. Still, Baron von Ettingshausen is probably correct in presuming that the American form is a nearly related species rather than identical with the Croatian.

Quercus Carbonensis, n. sp.

Plate IX, Fig. 6.—Carbon Station, Wyoming.

Leaf 8cm. broad, rounded at the base, slightly sinuate-margined between the distant sharp, cuspidate, or spinulose teeth; petiole 6cm. long, thick and flexuous; midrib thick and straight, giving off strong secondaries at short ntervals, which are slightly curved outward and upward and pass out toward the margins parallel to one another; nervilles few, straight or flexed near the middle, percurrent, forked or obliquely joined; nervation chiefly camptodrome.

The entire upper portion of this leaf is wanting, but the lower half, including the petiole, is highly distinctive. The nervation and the spinous teeth, or lobes, strongly suggest its affinity to Quercus, but the petiole is too long and flexuous for most species of that genus. Better material will be necessary to decide the question.

Quercus Dentoni Lx.

QUERCUS DENTONI Lx., Cret. & Tert. Fl., p. 224, pl. xlviii, figs. 1, 11.

Plate X, Fig. 1. Point of Rocks, Wyoming; gray sandstone bed north of station.

The close resemblance between this specimen and that figured by Lesquereux from the Bad Lands of Dakota inclines me to class them together for the present rather than to multiply species. The shape, however, is somewhat different, the Wyoming specimen being more narrowed upward and indicating a contracted apex. The petiole is also thicker and slightly inflated, recalling some species of Ficus.

DRYOPHYLLUM Debey.

I have already referred (Sixth Ann. Rep. U. S. Geol. Surv., p. 534) to the numerous forms probably referable to this genus, rather than to Quercus, which appear in my collections. A few of them are illustrated.

Dryophyllum aquamarum, n. sp.

Plate X, Figs. 2-4.—Black Buttes Station, Wyoming.

Leaves lanceolate, narrowed at both ends, broadest at or below the middle, 3 to 5 cm. broad, 10 to 15 cm. long, entire or wavy near the base, undulate or sinuate-toothed above; nervation mixed; midrib strong; secondary nerves numerous (fifteen to twenty on each side) and close together, alternate, irregular as to interval and angle, often having intercalary nerves between them, which proceed from the midrib at a wider angle and unite with the next nerve below; nervilles very prominent, joining the secondaries to one another and the midrib to the secondaries, these latter strong, curved, and often passing into intercalary nerves.

These leaves appear to belong to the subgenus Dryophanes of Debey and to have their nearest analogue in his *Dryophyllum Eodrys* (Feuilles quercifomes, pp. 11, 14, fig. 19), but there is much in the nervation that reminds one of *Quercus Lucumonum* Gaud. (Contr. II, Nouv. Mém. Soc. Helv. Sci. Nat., Vol. XVII, pl. x, fig. 12). The irregular character of the secondary nerves very closely resembles some forms that have been referred to *Quercus furcinervis* (Rossm.) Ung. (cf. Lesquereux, Cret. and Tert. Fl., pl. liv, figs. 1, 2), but the camptodrome tendency as they approach the border, which is characteristic of Dryophyllum, is not found in that species. The tertiary nervation is very prominent and distinguishes these leaves from any others I have seen. The specimens figured all come from the same bed, and all the gradations between the strongly camptodrome forms (Figs. 2, 3) and the distinctly craspedodrome forms represented by Fig. 4 occur in the collection; their reference to Salix seems therefore out of the question.

Dryophyllum Bruneri, n. sp.

Plate X, Figs. 5–8.—Point of Rocks, Wyoming; gray sandstone bed (Figs. 5, 6). Hodges Pass, Wyoming (Figs. 7, 8).

Leaves lanceolate or oblong-lanceolate pointed, abruptly narrowed to a short thick petiole, coarsely and obscurely to sharply sinuate-toothed except the entire base; nervation craspedodrome; midrib strong, straight or a little curved; secondary nerves numerous (fifteen to twenty on each side) and close together, proceeding from the midrib at an angle varying from 35° to 80°, slightly curving upward, rarely forking or forming arches, the ultimate ramifications entering the teeth; nervilles faint, slender and wavy, percurrent, joining the secondaries only (except in a few cases).

I dedicate this species to Prof. Lawrence Bruner, of Nebraska, who was my companion throughout most of my campaign in Colorado and Wyoming and who rendered much valuable aid in making the collections at both the points named. The specimens closely resemble those last described, but the distinctly craspedodrome nervation and the great difference in the nervilles lead me to regard them as specifically distinct. Intercalary nerves do indeed appear in some specimens (Figs 5, 8) and nervilles occasionally proceed from the midrib (Figs. 6, 8), but these cases are rare. The arches formed by the secondaries in Figs. 7 and 8 are farther from the margin than those of *D. aquamarum* and different in character.

I have not found it possible to separate these specimens, although they come from different localities. If any separation were possible the specimens, Figs. 5 and 8, would naturally fall together, as nearer alike than they are to the other two, but some variation must be allowed, and they are probably all of one species.

Dryophyllum falcatum, n. sp.

Plate XI, Fig. 1.—Hodges Pass, Wyoming.

Leaf ovate-lanceolate, slender-pointed, and falcate at the summit, 8.5cm. long, broadest (2.5cm.) near the base, which is rapidly narrowed, obscurely sinuate-toothed above, entire at the base; midrib thick below, rapidly diminishing above; secondaries light, twelve to fourteen on a side, parallel (except the lowermost, which are more erect), unequally distant, simple or forked near their extremities, scarcely reaching the margin; nervilles indistinguishable.

This species also somewhat resembles *D. Eodrys* Deb. (Feuilles querciformes, fig. 19), but it is more falcate and pointed and the secondaries are more regular and parallel.

Dryophyllum basidentatum, n. sp.

Plate XI, Fig. 2.—Carbon Station, Wyoming.

Leaf obovate in outline, 4cm. broad above, long petioled, wedge shaped at the base, distantly and sharply sinuate-toothed, with prominent sub-

spinulose teeth, oblique at the base; petiole very thick, especially below, 3cm. long; midrib straight, diminishing above; secondary nerves five or six on a side, close together, parallel, ascending at an angle of 30° to the midrib, curving upward and inward toward the summit, where they give off five or six tertiaries; nervilles distinct, wavy, percurrent or forked, often crossed by short veins at right angles, forming fine quadrilateral meshes.

The upper portion of this leaf is wanting, but the form and the nervation of the parts preserved indicate a rapid narrowing to the apex, which was probably more or less toothed.

I should have been disposed to regard this as a species of Quercus but for its striking resemblance to *Dryophyllum cretaceum* Deb., particularly as figured by Saporta in his Flora of Gelinden, pl. v., figs. 3, 4. The nerves in our specimen are, however, a little more erect and nearer together and the teeth near the base are decidedly more prominent and conspicuous. It may prove to be the same as *Quercus Carbonensis* (Pl. IX, Fig. 6), from which it differs chiefly in size and in its wedge shaped base.

CORYLUS Tournef.

The same forms of Corylus described by Newberry in his Later Extinct Floras recur at nearly all points in the Fort Union group. I obtained them all, unless it be his *C. orbiculata*, as I believe he now admits his *C. grandifolia* to be identical with Heer's *C. McQuarrii*. I have carefully compared my larger specimens with all the published figures of *C. McQuarrii* and also with specimens of *C. Americana*, *C. rostrata*, and *C. Avellana*, and I am compelled to conclude that there is scarcely a specific difference between *C. McQuarrii* and *C. Americana*. It is singular that Heer, in comparing his fossil forms with living ones, makes no mention of this most common American species so similar to his fossil one. He compares his *C. insignis* with *C. rostrata* and *C. McQuarrii* with *C. Avellana*, and remarks that the larger fossil species resembles the larger living one, except that the leaves rapidly grow narrower above the middle, while in the living form the broadest part is above the middle. He also mentions the resemblance in the nervation of the two more robust forms as being more prominent, with the nerves in relief. Now these are just the characters, and almost the only ones, which distinguish *C. Americana*.

Corylus Americana Walt.

CORYLUS AMERICANA Walt., Newberry, Later Extinct Floras, pp. 31, 59; Illustrations of Cret. and Tert. Plants, pl. xiv, figs. 8, 10. Schimper, Pal. Vég., Vol. II, p. 600. Dawson, Cret. and Tert. Fl. Brit. Col. and N. W. Terr., Trans. Roy. Soc. Can., Sec. IV, p. 32.

Plate XI, Figs. 3–5; Plate XII, Figs. 1, 2.—Seven Mile Creek, Montana; white marl bed.

My specimens are larger than those figured by Newberry under this name, but it is easy to find living leaves as large. The figures of *C.*

McQuarrii are also generally smaller than those here figured, but the one represented by Fig. 1 agrees in all respects with Heer's figure of *C. McQuarrii* in his Flora of Grinnell-Land (Fl. Foss. Arct., Vol. V, Pt. I, pl. vi, fig. 6). I also find leaves of the living species that exactly correspond to both these figures. Usually, however, the teeth of *C. McQuarrii* are represented as less sharp.

Corylus rostrata Ait.

CORYLUS ROSTRATA Ait., Newberry, Later Extinct Floras, pp. 31, 60; Illustrations of Cret. and Tert. Plants, pl. xv, figs, 1, 3. Schimper, Pal. Vég., Vol. II, p. 600. Dawson, Cret. and Tert. Fl. Brit. Col. and N. W. Terr., Trans. Roy. Soc. Can., Sec. IV, p. 32.

Plate XIII, Figs. 1–4.—Seven Mile Creek, Montana; white marl bed.

These specimens correspond very well with those figured by Newberry (Illustr., pl. xv, figs. 1–3), but our Fig. 4, which agrees with his fig. 3, may belong to another species.

Corylus Fosteri, n. sp.

Plate XIII, Figs. 5, 6.—Head of Clear Creek, Montana (Fig. 5); Clear Creek, Montana (Fig. 6); collected by Mr. Richard Foster, for whom it is named.

Leaves ovate, deeply heart shaped, the lobes of the base unequal, long pointed, the entire margin toothed, the unequal teeth broad at the base and somewhat obtuse; midrib strong, slightly sinuous or curved; secondary nerves seven or eight on each side, the two lowest opposite and sending out five or six strong tertiary nerves, the first of which arise from near the midrib and in turn give off quaternary nerves to the basal lobes, the next three or four secondaries supporting each a few branches toward the summit, the upper ones simple; nervilles very prominent, mostly percurrent, at right angles to the secondaries, often joined near the middle by oblique veins forming irregular meshes, sometimes forking, those connecting the midrib with the secondaries much curved, often opposite and appearing to form concentric circles.

It is fitting that I should name this handsome species of Corylus in honor of Prof. Richard Foster, now of Howard University, who collected both the specimens figured here and through whose zeal and energy the rich bed at the head of Clear Creek, where the finest specimen was found, was visited.

I formerly regarded the smaller of the two specimens which accompanied Dr. White's collection of the year previous as representing Newberry's *C. orbiculata*, but it differs from that form in having teeth of a different shape and identical with those of the larger specimen. Although the summit is wanting it is evident from the rest of the leaf that this was narrowed to a point.

? Corylus McQuarrii (Forbes) Heer.

CORYLUS MCQUARRII (Forbes) Heer, Fl. Foss. Arct., Vol. I, p. 104, pl. viii, figs. 9–12; pl. ix, figs. 1–8; pl. xvii, fig. 5*d*; pl. xix, fig. 7*c*; p. 138, pl. xxi, fig. 11*c*; pl. xxii, figs. 1–6; pl. xxfii, fig. 1; p. 149, pl. xxvi, figs. 1*a*, 2–4; p. 159, pl. xxxi, figs. 1*b*, 5, 6*a*; Vol. II, Pt. II (Fl. Foss. Alask.), p. 29, pl. iii, fig. 9; pl. iv; Pt. III (Mioc. Fl. Spitzbergens). p. 56, pl. xi, figs. 10–13; pl. xiii, fig. 35*b*; Pt. IV (Foss. Fl. Greenland), p. 469, pl. xliv, fig. 11*a*; pl. xlv, fig. 6*b*; Vol. IV, Pt. I (Foss. Fl. Spitzbergens), p. 72, pl. xv, figs. 1–4; pl. xxviii, figs. 7, 8; Vol. V, Pt. I (Mioc. Fl. Grinnell-Land.), p. 33, pl. v, fig, 9; pl. vi, figs. 3–6; pl. viii, fig. 9*a*; pl. ix, fig. 1; Pt. III (Prim. Fl. Foss. Sachal.), p. 34, pl. vii, figs. 8, 9*a*. Lesquereux, Tert. Fl., p. 144, pl. xviii, figs. 9–11; Cret. and Tert. Fl., p. 223, pl. xlix, fig. 4. Ettingshausen, Foss. Fl. v. Sagor, I (Denkschr. Wien. Acad., Vol. XXXII), p. 177, pl. iv, figs. 20, 21. Schimper, Pal. Vég., Vol. II, p. 598. Zwanziger, Mioc. Fl. v. Liescha, p. 35, pl. viii, figs. 3, 4.

ALNITES MCQUARRII Forbes, Quart Journ. Geol. Soc., Vol. VII, 1851, p. 103, pl. iv, fig. 3.

Plate XIII, Fig. 7.—Seven Mile Creek, Montana; bed below the ironstone.

This very anomalous leaf, the only one of the kind in the collection, comes from the next lowest horizon at Seven Mile Creek. Its reference to the genus Corylus is very doubtful, but it agrees tolerably well with some of the figures of Heer. The midrib, however, and the three opposite pairs of secondary nerves are unlike Corylus and resemble Alnus or Betula. That it is not a form of *Alnus Kefersteinii* I would not affirm, but the projection of the teeth at the extremities of the secondary nerves and the general form of the upper portion strongly suggest its reference to Corylus. Unwilling to make a new species on so defective material, and yet desiring the judgment of others upon it, I venture to enter it as above.

ALNUS Gärtn.

Unless the specimen last mentioned represents an Alnus only one has been selected referable to that species.

Alnus Grewiopsis, n. sp.

Plate XIV, Fig. 1.—Hodges Pass, Wyoming.

Leaf obovate, obtuse, sinuate, and somewhat doubly toothed above, entire or slightly undulate margined below, 4cm. broad, 7cm. long, exclusive of the petiole (1cm.); midrib strong, somewhat curved, rapidly diminishing toward the summit; secondary nerves about nine on each side, the strongest near the middle of the leaf, nearly parallel and straight, making an angle of about 30° with the midrib, the lower ones giving off short simple tertiaries, which usually lose themselves near the entire margin, the upper either passing directly into the teeth or curving and forming angular arches near the border, from which finer veinlets proceed to the lesser as well as to the principal teeth; nervilles faint, mostly straight and percurrent, sometimes forked.

The specific name is suggested by a peculiar character in the nervation near the upper border closely resembling that of some species of Grewiopsis, e. g., *G. Saportana* Lx. (Tert. Fl. pl. l, fig. 11); *G. Cleburni* Lx. (op. cit., pl. lxii, fig. 12). The form and general nervation, however, are those of an Alnus.

BETULA L.

Numerous specimens belonging to this genus occur in the collections, of which the following four are figured.

Betula prisca Ett.

BETULA PRISCA Ett., Foss. Fl. v. Wien, p. 11, pl. i, figs. 15–17; Foss. Pfl. v. Heiligen Kreuz bei Kremnitz (Abh. K. K. Geol. Reichsanstalt, Vol. I), p. 5, pl. i, fig. 3; Foss. Fl. v. Bilin, I (Denkschr. Wien. Acad., Vol. XXVI), p. 121, pl. xiv, figs. 14–16; Tert. Fl. Steiermark's (Sitzb. Wien. Acad., Vol. LX, Abth. I), p. 45, pl. i, figs. 24–26. Göppert, Tert. Fl. v. Schossnitz, p. 11, pl. iii, figs. 11, 12. Massalongo, Synops. Fl. Foss. Senog., p. 24; Fl. Foss. del Senigal., p. 172, pl. xxxvi, fig. 9. Heer, Mioc. Balt. Fl., p. 70, pl. xviii, figs. 8–15; Fl. Foss. Arct., Vol. I, p. 148, pl. xxv, figs. 9*a*, 10, 20–25; pl. xxvi, figs. 1*b*, 1*c*; Vol. II, Pt. II (Fl. Foss. Alask.), p. 28, pl. v, figs. 3–7; Pt. III (Mioc. Fl. Spitzbergens), p. 55, pl. xi, figs. 3–6; Vol. IV, Pt. I (Foss. Fl. Spitzbergens), p. 70, pl. xxxi, fig. 10; Vol. V, Pt. I (Mioc. Fl. Grinnell-Land.), p. 31, pl. iii, fig. 3*h*; pl. v, figs. 2–5; Pt. III (Prim. Fl. Foss. Sachal.), p. 30, pl. v, figs. 9, 10; pl. vii, figs. 1–4; Pt. IV (Mioc. Pfl. v. Sachal.), p. 6, pl. ii, fig. 8; pl. iii, fig. 6. Gaudin, Contr. IV (Nouv. Mém. Soc. Helv., Vol. XVII), p. 20, pl. i, fig. 14; Contr. VI (op. cit., Vol. XX), p. 12, pl. ii, fig. 10. Engelhardt, Fl. d. Braunk. Sachsen, p. 16, pl. iii, figs. 19–21. Schimper, Pal. Vég., vol. ii, p. 567.

Plate XIV, Fig. 2.—Seven Mile Creek, Montana; bed below the ironstone.

The remarkable agreement between our specimen and the original figure upon which the species was founded does not permit me to hesitate in referring it to that species. The species is a widespread and variable one, but occasionally, as in Heer's Miocene Baltic Flora (pl. xviii, fig. 11), there is a return to the type, and ours seems to constitute another such case.

Betula coryloides, n. sp.

Plate XIV, Fig. 3.—Seven Mile Creek, Montana; white marl bed.

Leaf ovate-lanceolate, 2.5cm. wide, 5cm. long, irregularly doubly or trebly toothed, entire at the horizontal base, recurved pointed at the summit; petiole 12mm. long; midrib strong, nearly straight; secondary nerves eight on each side, making an angle with the midrib of about 35°, the lowest and some of the higher pairs opposite, very thick at the base, rapidly diminishing to the margin of the leaf, the lowest pair giving out each a strong horizontal tertiary nerve from near its insertion, which terminates in a slightly prolonged tooth or lobe and gives off several quaternary nerves from the lower side; lower and middle secondaries all yielding tertiaries, upper ones simple; nervilles very promi-

nent, mostly straight, percurrent, and at right angles to the secondaries but often forking, flexed, and variously joined, forming irregular meshes

The prominent nervilles and double dentation, and especially the pai of horizontal tertiary nerves at the base, assimilate this leaf very closel to the genus Corylus, where it would find its nearest analogue in *C. insignis* (cf. Heer, Fl. Tert. Helv., pl. lxxiii, figs. 11–17); but upon th whole the nervation perhaps agrees as well with that of Betula, whil the general shape is much nearer that of most leaves of that genus. I resembles quite closely some forms of *B. prisca*, particularly the on figured by Heer in his Arctic Flora (Vol. I, pl. xxv, fig. 20), but a stil nearer approach to our form is found in *B. lutea* Michx. f., of the pres ent North American flora.

Betula basiserrata, n. sp.

Plate XIV, Fig. 4.—Seven Mile Creek, Montana; white marl bed.

Leaf roundish ovate, sharply simply serrate, 3cm. wide, 3.5 or 4cm long; midrib straight; secondary nerves five or six on a side, making a angle of 40° with the midrib; the lowest pair opposite, arising at a les angle and curving outward, furnished with five to seven simple tertia ries, which pass into the teeth, the next one or two on each side havin a few tertiaries near their extremities, the upper one simple; nerville indistinct, curved percurrent, sometimes forked.

In this specimen the teeth approach the base of the leaf more closel than is usual with the genus. Otherwise there seems to be no reaso to exclude it.

MYRICACEÆ.

MYRICA L.

Only two species of this abundant type occur in the Laramie group The thirty-five species of the living flora are distributed throughou nearly all temperate parts of the world. Two species are very abun dant in North America, either or both of which may have descende from these fossil forms.

Myrica Torreyi Lx.

MYRICA TORREYI Lx., Ann. Rep. Geol. Surv. Terr., 1872, pp. 392, 399; Tert. Fl., p 129, pl. xvi, figs. 3–10. Schimper, Pal. Vég., Vol. III, p. 586.

Plate XIV, Fig. 5.—Black Buttes Station, Wyoming.

The specimen represents a leaf of about the maximum length (15cm. of the plant described by Lesquereux from the same locality in 1872. I has not been found at any other place. The absence of marginal nerve is in favor of the reference of this leaf to Myrica, while their presenc in the earlier described specimens points, as Baron von Ettingshause suggests, to Lomatia as their more probable affinity.

JUGLANDACEÆ.

JUGLANS L.

Five of the eight surviving species of Juglans are North American and the Laramie group has hitherto yielded eight extinct ones. One of the following is not included in these, and if correctly referred will increase this number to nine.

? Juglans Ungeri Heer.

JUGLANS UNGERI Heer, Tert. Fl. Helv., Vol. III, p. 199, pl. clv, fig. 18; Braunk. Pfl. v. Bornstädt, p. 21, pl. iv, fig. 13. Schimper, Pal. Vég., Vol. III, p. 241. Engelhardt, Foss. Pfl. v. Tschernowitz (Nova Acta L.-C. Acad., Vol. XXXIX), p. 385, pl. xxiii, fig. 2; Foss. Pfl. v. Grasseth (op. cit., Vol. XLIII), p. 313, pl. xxi, figs. 3, 5, 6.

PHYLLITES JUGLANDOIDES Rossm., Verstein. d. Braunk. v. Altsattel, p. 29, pl. iv, fig. 16.

JUGLANS COSTATA Ung. (quoad folia), Gen. et Spec., p. 468. Heer, Fl. Tert. Helv., Vol. III, pp. 90, 199. Ludwig, Palæontogr., Vol. VIII, p. 138, pl. lvi, fig. 7; pl. lvii, figs. 6, 7.

Plate XIV, Fig. 6.—Burns's Ranch, Montana.

Our specimen closely resembles the Swiss plant and also the one from Altsattel, but finds its nearest analogue in the specimen from Tschernowitz, as figured by Engelhardt, with which it agrees in having nearly all the secondary nerves opposite.

? Juglans nigella Heer.

JUGLANS NIGELLA Heer, Fl. Foss. Arct., Vol. II, Pt. II (Fl. Foss. Alask.), p. 38, pl. ix, figs. 2–4; Vol. V, Pt. III (Prim. Fl. Foss. Sachal.), p. 41, pl. x, figs. 6, 7; pl. xi, figs. 1, 2; Pt. IV (Mioc. Pfl. v. Sachal.), p. 9, pl. iv, fig. 10. Schimper, Pal. Vég., Vol. III, p. 247, pl. cii, fig. 4. Lesquereux, Cret. and Tert. Fl., p. 235, pl. xlviA, fig. 11.

Plate XV, Fig. 1.—Burns's Ranch, Montana.

Much difficulty has been experienced in separating leaves of similar nervation to the present one into their proper genera. For a long time I had classed this with the forms referred to the Celastraceæ, and I am not yet certain that it does not belong there. Its affinities are closest with those that I have grouped under the genus Elæodendron (Pl. XXXVII, Figs. 3–5; Pl. XXXVIII, Figs. 1–7), all but one of which were collected in the same bed at Burns's Ranch. But these all show a greater tendency to form a double series of arches at a greater distance from the margin and the nerves are more regular than in this one. The teeth in this specimen are also finer and sharper. It agrees in nearly all respects with the figures of *Juglans nigella* above cited, and is as likely as they to belong to that genus. Whether this will necessarily carry some of the other leaves into Juglans remains to be seen.

CARYA Nutt.

Although the ten species of Carya are all North American, there is abundant evidence that the type played an important rôle in the Miocene epoch in Europe. About twenty species are found there and only four or five in North American strata. Only one of these latter is from the Laramie group.

Carya antiquorum Newberry.

CARYA ANTIQUORUM Newberry, Later Extinct Floras, pp. 31, 72; Illustrations of Cret. and Tert. Plants, pl. xxiii, figs. 1–4. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1871, p. 294; 1872, p. 402; Tert. Fl., p. 289, pl. lvii; lviii, fig. 2. Schimper, Pal. Vég., Vol. III, p. 255. Dawson, Cret. and Tert. Fl. Brit. Col. and N. W. Terr. (Trans. Roy. Soc. Can., Sec. IV), p. 32.

Plate XV, Fig 2.—Carbon Station, Wyoming.

Less than half the leaf is preserved, but this includes the nearly complete petiole and shows the nervation very clearly. This resembles that of the Fort Union specimens less than it does those from Evanston, which is probably nearly on the same horizon with Carbon. Prof. Lesquereux's fig. 2 of pl. lvii represents a fragment very similar to this one, but the fine teeth come farther down. This specimen is not in the Museum collection, but I have examined those represented by figs. 3 and 4 of the same plate, and I have no doubt that our plant belongs to the same species.

PLATANACEÆ.

PLATANUS L.

Six species of this very ancient type survive and are confined to the northern hemisphere, two being North American. Eight fossil species have hitherto been described from the Laramie group.

Platanus Heerii Lx.

PLATANUS HEERII Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1871, p. 303; 1872, p. 425; 1874, p. 341, pl. viii, fig. 5; Cret. Fl., p. 70, pl. viii, fig. 4; pl. ix, figs. 1, 2; Cret. and Tert. Fl., p. 44, pl. iii, fig. 1; pl. vii, fig. 5. Schimper, Pal. Vég., Vol. III, p. 591. Heer, Fl. Foss. Arct., Vol. VI, Abth. II (Foss. Fl. Grönlands), p. 72, pl. vii, figs. 1, 2; pl. viii, figs. 1, 2*a*; pl. ix, figs. 1–4.

Plate XV, Figs. 3, 4.—Black Buttes Station, Wyoming.

Prof. Lesquereux, to whom I have recently sent figures of this leaf, thinks that the basilar origin of the lateral primary nerves and the more strongly toothed margin are fatal to the reference of this leaf to *P. Heerii*. He considers its affinities to be rather with his *Viburnum platanoides* (Tert. Fl., p. 224, pl. xxxviii, fig. 8), or perhaps with *Platanus affinis* Lx., especially the arctic forms (Heer, Fl. Foss. Arct., Vol. VII, pl. lvii, figs. 1–6), or even with *P. Guillelmæ* (op. cit., Vol. V, Pt. II, Foss. Fl. Sibir., pl. ix, fig. 14). The general resemblance of the

leaves to those figured by Heer (Fl. Foss. Arct., Vol. VI, Abth. II, pl. vii, fig. 1) as *P. Heerii*, is very striking, but here the origin of the lateral primaries is still higher than in either of my specimens.

Platanus nobilis Newberry.

PLATANUS NOBILIS Newberry, Later Extinct Floras, pp. 30, 67; Illustrations of Cret. and Tert. Plants, pl. xvii. Lesquereux, Ann. Reps. Geol. Surv. Terr., 1871, p. 295; 1872, p. 404. Schimper, Pal. Vég., Vol. II, p. 708. Dawson, Foss. Pl. of Roche Percée (Geol. Surv. Can., Rep. of Prog., 1879–'80, App. II), p. 51; Cret. and Tert. Fl. Brit. Col. and N. W. Terr. (Trans. Roy. Soc. Can., Sec. IV), p. 32.

Plate XVI, Fig. 1.—Seven Mile Creek, Montana; Sparganium bed.

This leaf is the largest collected in the Yellowstone Valley, and measures 35cm. across its broadest portion, while the midrib is preserved for about 30cm. It resembles very closely Newberry's figure (Illustr., pl. xvii), but is strictly three lobed, whereas that shows a fourth lobe of diminished length formed by a prepotent secondary nerve given off by one of the lateral primaries. The base is remarkably similar, the paranchyma not extending as far down as the origin of the principal nerves, and these in both cases are somewhat alternate. Numerous fragments in the Museum collection (No. 1070) recorded by Lesquereux in the catalogue as from Fort Clarke, but which may be the same as he mentions in the Annual Report for 1872 (p. 403) as from "Elk Creek, near Yellowstone River," agree substantially with our leaf. I should be very glad of an opportunity to examine the Evanston specimens mentioned in the Annual Report for 1871 (p. 295), as they must possess considerable interest in connection with the question of correlating the Fort Union with the Wyoming Laramie; but these are not in the Museum type series. Baron von Ettingshausen regards this species as an Aralia (in litt. 24. Aug. 1886). See, *infra*, pp. 59–61, remarks on the genus Aralia, and especially on *A. notata*.

Platanus basilobata, n. sp.

Plate XVII, Fig. 1; Plate XVIII, Figs. 1–3, 3*a*, enlarged; Plate XIX, Fig. 1.—Seven Mile Creek, Montana; Sparganium bed (Plates XVII, XVIII). Clear Creek, Montana, collected by Dr. White's party in 1882 (Plate XIX).

Leaves large (25 to 35cm. wide), with nearly entire margins, long petioled, three lobed above and provided with a three to six lobed appendage at the base; nervation strongly palmate, camptodrome, the three principal nerves all rising from the same point and near the summit of the petiole, the four to eight nerves of the basilar appendage proceeding from the same point in the opposite direction; primary nerves provided with secondaries on both sides, some of the lower secondaries giving off tertiaries from the under side; nervilles distinct, close together, mostly irregular, curved or wavy, sometimes percurrent, more frequently forked or obliquely joined near the middle, the areolæ, as also the interval between the arches and the margin, occupied by fine network of regular quadrate meshes.

This remarkable form differs specifically from *P. nobilis* in its decidedly camptodrome nervation and entire margins, but especially in the peculiar basilar appendage above described. This is not preserved with absolute completeness in any of my specimens, but in several it is nearly complete, and by comparing them all there is no difficulty in understanding its nature. It seems to consist of a miniature reflex of the leaf itself projected backward over the petiole as a lobate expansion. It is palmately nerved like the blade, the principal nerves entering the lobes. These sometimes differ in number from those of the leaf, amounting to six in two of the specimens (Pl. XVII, Fig. 1; Pl. XVIII, Fig. 1). The lobes also vary considerably in length and shape. In Fig. 3, Plate XVIII, the base is wanting, the leaf is small, and the upper lobes are quite short, but the nervation is here very distinct and is identical with that of the other specimens. The specimen from Clear Creek seems also to be identical with the others in all that is essential to the species. The basilar appendage, which is here nearly perfect, is only three-lobed, but the same is true of one of the specimens from Seven Mile Creek (Pl. XVIII, Fig. 2).

This basilar appendage is extremely interesting. It is not stipular, since it arises from the summit of a petiole of considerable length, as shown in Plate XVII, where 6cm. of it are preserved without showing the attachment. The appendage is, moreover, not bracteal, but it is a veritable part of the main blade, to which it is joined by a broad (1.5 to 2 cm.) neck of parenchymatous tissue. It has very few analogues in the living flora, but something faintly resembling it occurs in some leaves of *Platanus occidentalis*, so common in the valleys of nearly all the rivers of North America. Long before I had seen the fossil specimens I had remarked that certain very vigorous leaves of that tree, usually such as grow from young shoots about the base of stumps, exhibit a sort of basilar appendage somewhat resembling the lobed stipules of the same species, which are also most prominent on such shoots, and I had collected and preserved specimens of these leaves to illustrate this peculiarity. Upon a comparison of these appendages with those of the fossil form I find that they are clearly homologous. Since collecting the latter I have lost no opportunity to study this phenomenon in the living plant. I find various transitions from the naked leaves (resembling in this respect those of *P. orientalis*, in which I have never seen any tendency toward basilar lobation) to forms with quite large and somewhat lobed and nerved expansions, though the nervation seems here to be rather pinnate than palmate, the intermediate forms consisting of a more or less winged petiole. Certain stipular appendages occur, however, which have precisely the form and nervation of the lobes of the extinct species, including the tendency to augment the number of primary nerves and lobes. These are not always true leaf stipules, but appear lower down on the young leaf-bearing branches. In *P. appendiculata* Lx. (Foss. Pl. Aurif. Gravels, pl. iii, fig. 3) there occur large stipular append-

ages wholly detached from the blade, yet near to it—apparently a transition or intermediate form. Prof. Leo Lesquereux has recently figured a form from the Dakota group which still more closely resembles our plant so far as the basilar appendage is concerned. He calls it an Araliophyllum, but there seems no doubt of its genetic affinities with these forms of Platanus. The Marquis Saporta, to whom figures of *P. basilobata* were sent, suggests its affinity with Pterospermum.

In considering all these facts it becomes difficult to escape the conviction that the basilar expansions of our North American species possess a phylogenetic significance in connection with those of the fossil form, and if no other result is attained, some degree of confidence will be thereby inspired that in referring these anomalous forms (e. g., *P. nobilis*) to this genus their natural relationships have been rightly divined.

Platanus Guillelmæ Göpp.

PLATANUS GUILLELMÆ Göpp., Tert. Fl. v. Schossnitz, p. 21, pl. xi, figs. 1, 2; pl. xii, fig. 5. Schimper, Pal. Vég., Vol. II, p. 707. Heer, Fl. Foss. Arct., Vol. II, Pt. IV (Foss. Fl. N. Greenld.), p. 473, pl. xlvii–xlix, figs. 4*b*, *c*, *d*, 6*b*; Vol. V, Pt. II (Foss. Fl. Sibir.), p. 40, pl. ix, figs. 14–16; pl. x, figs. 1–4*a*; pl. xi, fig. 1; pl. xiii, figs. 5*b*, 6*b*. Lesquereux, Tert. Fl., p. 183, pl. xxv, figs. 1–3.

Plate XX, Fig. 1.—Burns's Ranch, Montana; collected by Dr. White's party in 1882.

This is one of the most perfect specimens of this species that have been figured. Its petiole is complete, and is 3cm. in length, slightly dilated at the point of attachment. The leaf is small (6.3cm. wide) and agrees better with the original figures of Göppert, especially his first one (Tert. Fl. v. Schossnitz, pl. xi, fig. 1), than any of the American or arctic forms.

Platanus Raynoldsii Newberry.

PLATANUS RAYNOLDSII Newberry, Later Extinct Floras, pp. 30, 69; Illustrations of Cret. and Tert. Plants, pl. xviii. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1872, pp. 379, 399; Tert. Fl., p. 185, pl. xxvii, figs. 1–3. Schimper, Pal. Vég., Vol. II, p. 708.

Plate XX, Figs. 2, 3.—Clear Creek, Montana; collected in 1882 by Dr. White's party.

The two specimens here figured correspond well with those from Golden as represented by Lesquereux on plate xxvii of the Tertiary Flora. Like his, they want the upper portion and lateral lobes. They are less in accord with Dr. Newberry's specimen, and differ from all others in the possession of a pair of quite strong and ascending nerves arising some distance below the insertion of the principal lateral primaries and passing upward and outward, giving off a few secondaries to the lowest teeth.

URTICACEÆ.

FICUS L.

Twenty species of Ficus have thus far been reported from the Laramie group none of which have been collected in typical strata of the Fort Union group. Upon a critical examination of these species, how-

ever, as will be seen by the table in the Sixth Annual Report (p. 482), I have referred six of them to that group. Three of these are from the localities of the upper districts which Lesquereux regards as equivalent to the Laramie of Colorado, but which seem to me to form the western extension of the Lower Yellowstone beds (cf. loc. cit., p. 441); two others occur in the British American Laramie, which is without doubt a northern extension of the true Fort Union terrane, while the one remaining species (*F. artocarpoides* Lx.), as well as one of the last named class (*F. tiliæfolia* Al. Br.), is from the Bad Lands of Dakota, which Mr. Lesquereux regards as Miocene, but which seem to me to form a southern extension of the Fort Union strata.

Among my Fort Union specimens I have thus far found three species referable to that genus which, if this reference is sustained, and even if no others should be detected, will show that a climate existed in the Fort Union epoch and at the latitude of Glendive warm enough and moist enough to permit these chiefly tropical plants to thrive.

On the other hand, four species were collected by me in the lower districts in 1881, and to these one is added from the collections of Mr. C. W. Cross, from Golden, Colo.

Ficus irregularis Lx.

FICUS IRREGULARIS Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1874, p. 304; Bulletin do., Vol. V, p. 368; Tert. Fl., p. 196, pl. xxxiv, figs. 4–7; pl. lxiii, fig. 9.
ULMUS IRREGULARIS Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1872, p. 378.

Plate XX, Figs. 4, 5.—Golden, Colorado.

The specimens are both from the tufa beds of South Table Mountain, near Golden, Colo., the first (Fig. 4) collected by Mr. C. W. Cross, the second (Fig. 5) by myself. Mr. Cross's specimen is nearly perfect to above the middle of the leaf and adds considerably to our previous knowledge of the species; my specimen also shows the basal portion, but for a shorter distance. It is remarkable in having a slightly heart-shaped base, in so far differing from all the other specimens known, and suggesting its reference to another species (e. g., *F. artocarpoides* Lx., cf. Cret. and Tert. Fl., pl. xlvii, figs. 2, 4, 5). Otherwise, however, it has the characteristic nervation of *F. irregularis*, including the anomalous forking of some of the secondary veins. In no other specimen I have seen are the fibrillose nervilles so clearly and perfectly shown as in this fragment.

Ficus spectabilis Lx.

FICUS SPECTABILIS Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1872, p. 379; Tert. Fl., p. 199, pl. xxxiii, figs. 4–6. Schimper, Pal. Vég., Vol. III, p. 595.

Plate XXI, Fig. 1.—Golden, Colorado; collected in November, 1881, by Mr. C. W. Cross for Mr. S. F. Emmons.

The more distant secondary nerves indicate the reference of this specimen to *F. spectabilis* rather than to *F. irregularis*, but the percur-

rent nervilles are more like those of the latter species. As the base is wanting, some doubt must remain respecting its true affinities.

Ficus Crossii, n. sp.

Plate XXI, Fig. 2.—Golden, Colorado: collected in 1881 by Mr. C. W. Cross for Mr. S. F. Emmons.

Leaves medium size for the genus (4.5cm. wide, 8cm. long), ovate-oblong, wavy margined; midrib thick, diminishing rapidly to the summit; secondary nerves about twelve on each side, forming an angle of 60° to 70° with the midrib, curving upward near the margin, parallel and equidistant, occasionally forking at the point of curvature; nervilles percurrent, straight, forming acute angles with the under side of the secondaries, regular and parallel.

The specimen is from the coarse white sandstone beds near Golden, but is preserved with considerable fidelity. It seems to have its nearest analogue in *F. arenacea*, described by Prof. Lesquereux from some unknown locality which he vaguely surmises to have been in the Green River group (see Ann. Rep. U. S. Geol. Surv. Terr., 1871, p. 300; Tert. Fl., p. 195, pl. xxix, figs. 1–5). It may also be compared with *F. multinervis* Heer (Tert. Fl., p. 194, pl. xxviii, fig. 8, not 7), of which I have not seen any specimens. It seems, however, to differ specifically from both these forms.

Ficus speciosissima, n. sp.

Plate XXI, Fig. 3.—Point of Rocks, Wyoming; gray sandstone bed north of station.

Leaves large (16cm. wide, 18cm. long), round ovate, deeply auriculate-cordate, entire margined, strongly palmately nerved; petiole short (3 cm.), curved or hooked, projecting little below the rounded auricles of the leaf, divided at the summit into three strong primary nerves, of which the central one retains about as many fibers as the two lateral, these forming an angle with it of about 40° and proceeding nearly straight to near the margin far above the middle, sending off from their outer side about ten well developed secondaries, the lowest of which on each side supports six to eight tertiaries, and these in turn several nerves of the fourth order; upper secondaries giving off successively fewer tertiaries; midrib naked for some distance above the insertion of the lateral primaries, then bearing three or four strong, alternate, distant nerves on each side, which branch in the same manner as those of the lateral nerves; secondary and tertiary nerves arching near the margin by angular curves, from which short, straight branches go direct to the margin; nervilles very prominent, mostly percurrent and curved, often forking, or joined once or twice in their course by perpendicular or oblique veinlets, the rectangular or trapezoidal areas thus formed further subdivided into fine quadrate or somewhat polygonal meshes.

This beautiful leaf approaches most closely in form and general nervation to certain large forms of *F. tiliæfolia* (cf. Unger, Foss. Fl. v. Sotzka, Denkschr. Wien. Acad., Vol. II, pl. xlvii, fig. 2; Göppert, Palæontographica, Vol. II, pl. xxxvii, fig. 1; Heer, Tert. Fl. Helv., Vol. II, pl. lxxxiii, fig. 7; Vol. III, pl. cxlii, fig. 25; Lesquereux, Tert. Fl., pl. lxiii, fig. 8; Zwanziger, Mioc. Fl. v. Liescha, pl. xvi, xvii), and it also has analogues in some species of Dombeyopsis (cf. *D. Heufleriana* Mass., Monogr. Dombeyac. Foss., plate; *D. Decheni*, Ludw., Palæontographica, Vol. VIII, pl. xlix, fig. 1; *D. tridens*, loc. cit., figs. 2, 3); but, aside from the hooked petiole, this form is distinguished from all others I have been able to compare with it by the character of the nervation in its ultimate ramifications joining the arches directly to the margin. This character is faintly imitated in Saporta's *Populus Massiliensis* (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IX, pl. iii, fig. 1), and still more faintly in *Tilia expansa* Sap. & Mar. (Vég. Foss. de Meximieux, pl. xxxviii, fig. 3; Monde des Plantes, p. 333, fig. 103, No. 5), but it reaches its most complete expression in certain forms of Cinnamomum, Laurus, &c. (cf. Rossmässler, Verstein., pl. i, figs. 1, 3, 4; Ettingshausen, Foss. Fl. v. Bilin, II, Denkschr. Wien. Acad., Vol. XXVIII, pl. xxxiii, figs. 4–22; Ludwig, Palæontogr., Vol. VIII, pl. xli, fig. 51). These leaves, however, differ widely in form from ours, but certain species of Cinnamomum have broad, though never heart-shaped, leaves (cf. *C. transversum* Heer, Fl. Tert. Helv., Vol. II, pl. xcv, figs. 10, 12), and at Black Buttes Station I collected some leaves (not yet fully figured), no larger than those figured by Heer, which seem to combine many of the characters of Ficus and Cinnamomum and closely to resemble this species.

Ficus tiliæfolia (Al. Br.) Heer.

FICUS TILIÆFOLIA (Al. Br.) Heer, Fl. Tert. Helv., Vol. II, p. 68, pl. lxxxiii, figs. 3–12; pl. lxxxiv, figs. 1–6; pl. lxxxv, fig. 14; Vol. III, p. 183, pl. cxlii, fig. 25; Mioc. Balt. Fl., p. 35, pl. viii, fig. 1; p. 74, pl. xxi, fig. 12. Ettingshausen, Fl. Tert. v. Bilin, I (Denkschr. Wien. Acad., Vol. XXVI), p. 156, pl. xxv, figs. 4, 5, 7, 10; Foss. Fl. Braunk. Wetterau (Sitzb. Wien. Acad., Vol. LVII, Abth. I), p. 844, pl. ii, fig. 9. Gaudin, Gisement de Feuilles de Toscane (Nouv. Mém. Soc. Helv., Vol. XVI), p. 34, pl. xii, fig. 11. Unger, Syllog., I, p. 14, pl. vi, fig. 2; Foss. Fl. v. Szantó (Denkschr. Wien. Acad., Vol. XXX), p. 8, pl. ii, fig. 9. Sismonda, Pal. Tert. du Piémont (Mem. Real. Accad. Sci. di Torino, Ser. 2, Vol. XXII, 1865), p. 436, pl. xvii, fig. 5. Schimper, Pal. Vég., Vol. II, p. 746. Lesquereux, Tert. Fl., p. 203, pl. xxxii, figs. 1–3; pl. lxiii, fig. 8; Foss. Pl. Aurif. Gravels, p. 18, pl. iv, figs. 8, 9. Engelhardt, Fl. d. Braunk. Sachsen (Preisschr. Fürstl. Jabl. Ges.), p. 19, pl. v, fig. 1; Tert. Fl. v. Göhren, p. 24, pl. iv, fig. 6; Tert. Pfl. Leitmeritz. Mittelgeb. (Nov. Act. L.-C. Acad., Vol. XXXVIII), p. 378, pl. xx, fig. 18; Foss. Pfl. v. Grasseth (Nov. Act. L.-C. Acad., Vol. XLIII), p. 298, pl. xv, figs. 1, 2; Zwanziger, Mioc. Fl. v. Liescha, p. 52, pl. xvi–xviii, figs. 1–3. Pilar, Fl. Foss. Susedana, p. 54, pl. viii, fig. 5. Velenowsky, Flora Vrsovic., p. 28, pl. vi, figs. 1–4.

CORDIA? TILIÆFOLIA Al. Br., Leonh. & Bronn, N. Jahrb. f. Min., 1845, p. 170.

Plate XXII, Fig 1.—Burns's Ranch, Wyoming.

Thus far only one specimen has been found in the collections that seems to be referable with considerable certainty to this widespread and variable species, and if the genus occurs at all in the Fort Union group this species is the one that might be most naturally looked for. The leaf is a little one-sided and the midrib turned to one side near the base, like many specimens of that species, and but for the somewhat alternate character of the lower pair of nerves it would closely resemble some of the forms figured by Heer (Fl. Tert. Helv., pl. lxxxiii, lxxxiv). It also forcibly recalls Lesquereux's *F. tenuinervis* (Cret. and Tert. Fl., p. 164, pl. xliv, fig. 4) from Alkali Stage Station near Green River, but the nervation is much stronger. While I have referred it with considerable confidence to Ficus, it is proper to say that forms that have been placed in other genera have many characters in common with it. This is especially the case with certain leaves in the Leguminosæ, and notably with Saporta's *Phaseolites fraternus* (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IV, 1865, pl. xiii, fig. 11) and Unger's *P. oligantherus* (Syllog. II, pl. vi, figs. 8, 9); also with Unger's *Dolichites maximus* (op. cit., pl. viii). Certain species of Cinnamomum also approach it very nearly in some respects, particularly *C. polymorphum transversum* (cf. Saporta, Études, op. cit., Vol. IX, pl. v, figs. 3, 4).

Ficus sinuosa, n. sp.

Plate XXII, Fig. 2.—Black Buttes Station, Wyoming.

Leaf lanceolate, oblique, and sinuate, acute at both ends, 1.5cm. wide, 5cm. long, entire; nervation distinct, pinnate, camptodrome; midrib strong, sinuate in two curves to follow the center of the leaf; secondary nerves about ten on each side, all except the short upper ones opposite, proceeding from the midrib at an angle of 45°, curving upward in passing toward the margin, near which they arch and anastomose with one another, often giving off fine veinlets from the summit of the arches, which curve close to the margin, forming a partial second row with small rhomboidal meshes, the lowest pair finer and making a less angle with the midrib; nervilles distinct, simple, straight, percurrent, joining the secondaries at right angles.

The petiole of this specimen is not preserved, but the blade has so many of the characters of Ficus that it seemed necessary to refer it to that genus. There are certain small lanceolate forms of *F. tiliæfolia* which it approaches in some respects (cf. Heer, Fl. Tert. Helv., pl. lxxxiii, fig. 5). One of the specimens referred by Lesquereux (Tert. Fl., pl. lxiii, fig. 4) to Ettingshausen's *F. Dalmatica* is somewhat sinuous and otherwise resembles ours, but in the original from Monte Promina (Denkschr. Wien. Acad., Vol. VIII, pl. vii, fig. 11) the resemblance is less marked.

Among the figures belonging to other genera which I have been able to compare the nearest analogues are: *Rhus zanthoxyloides* Ung. (Foss. Fl. v. Kumi, Denkschr. Wien. Acad., Vol. XXVII, pl. xiii, fig. 28),

Rhamnus Decheni Web. (Palæontogr., Vol. II, pl. xxiii, fig. 2*d*), and *Quercus Lamberti* Wat. (Pl. Foss. du Bassin de Paris, pl. xxxv, fig. 5). In the first two cases the finer details of the nervation are wanting, while that of our specimen does not agree with either Rhus or Rhamnus as well as with Ficus. As to the third case, where the nervilles are well shown and are characteristic of Quercus, they differ entirely from those of our specimen. The smaller angle, formed by the lowest pair of secondaries, is suggestive of the Laurineæ, but it is also a common character of Ficus, and upon the whole this seems the safest reference.

Ficus limpida, n. sp.

Plate XXII, Fig. 3.—Clear Creek, Montana.

Leaf lanceolate, pointed at both ends, falcate at the summit, dentate to near the oblique base, short petioled; nervation craspedodrome; midrib rather slender, curved in opposite directions below and above; secondary nerves, six on each side, proceeding from the midrib at an angle of 30° and gently curving upward in passing to the margin, alternate, the lowest giving off six or seven distinct tertiary nerves, which directly enter the teeth, several of the next higher ones provided with similar branches near their extremities, the uppermost simple; nervilles straight, simple, percurrent, close together and parallel, slightly tremulous-wavy, joining the secondaries to one another and also to the midrib.

On reconsidering the diagnosis made of the leaf in July, 1885, for the purpose of assigning a name to it in the list of types figured in the Sixth Annual Report, I find reason for doubting whether I should have referred it to Ficus rather than to Viburnum. Much of the margin is wanting, and it will probably be impossible to settle the question without more and better material.

Ficus viburnifolia, n. sp.

Plate XXII, Figs. 4-8.—Clear Creek, Montana.

Leaves thick and coriaceous, round-ovate, obliquely heart shaped, dentate above, with short broad teeth or nearly entire below; nervation very strong, forming deep depressions or prominent ridges in the rock, pinnate; midrib very thick below, rapidly diminishing above, usually much to one side of the middle, sometimes curved towards the narrower side; secondary nerves numerous (six or eight on each side), the lower ones very strong, several crowded together at and near the base of the leaf, the lowest passing downward and outward nearly parallel to the margin of the lobes, the others passing outward and curving upward, those on the narrower side of the leaf nearly straight, all more or less sympodially branched or forked, the ultimate ramifications entering the teeth or often curving near the margin and anastomosing with one an-

other, forming arches from which small nerves pass into the teeth; nervilles very conspicuous (deeply furrowing the matrix, in which in some cases the silicified tissue is well preserved), close together, percurrent, straight, simple, or rarely forked, joining all the other nerves nearly at right angles.

These fine and in many respects remarkable specimens were all obtained at Clear Creek, the one represented by Fig. 4 by Dr. White in 1882, the rest by myself a year later. They occurred in immediate association with the abundant Viburnum leaves to be described later on, which, as will be seen, vary greatly among themselves and seem to approach those we are now considering in some of their extreme forms. I had been struck from the first by the peculiarity in nearly all the Clear Creek specimens, that the lower secondaries were inclined to converge and huddle together near the base, not at a single point, but along a small portion of the midrib, and as these leaves exhibited the same character I was at first disposed to class them with the rest. On finding the two very one-sided specimens, however, represented by Figs. 5 and 8, my attention was specially attracted to their marked analogy in general form to some species of Ficus (cf. *F. tiliæfolia* Unger, Foss. Fl. v. Sotzka, Denkschr. Wien. Acad., Vol. II, pl. xlvi, figs. 4, 5; Heer, Fl. Tert. Helv., Vol. II, pl. lxxxiii, figs. 4, 10, 11; pl. lxxxiv, figs. 1–3; Sismonda, Terr. Tert. du Piémont, Mem. Reale Accad. Sci. di Torino, Vol. XXII, pl. xvii, fig. 5). The last specimen (Fig. 8) is the only one which presents the under surface of the leaf, showing the nervation in relief, and along with other differences it seems to have the border entire all round, whereas the rest are clearly dentate to below the middle, and, although it has been drawn as if entire, it is fair to say that some doubt is admissible as to whether this appearance may not have been due to the margin having been somewhat recurved at the time it was imbedded and to the failure of this dentate portion to be preserved. Were I not inclined to this view, I should feel compelled to separate this specimen from the rest and refer it to *F. tiliæfolia*. But, assuming them all to have been more or less dentate, such a reference is inadmissible, while at the same time the similarity of the nervation to that of Ficus is too great to be ignored. I have therefore decided for the present to regard them as belonging to that genus and to emphasize their general resemblance to the Viburnum leaves of Clear Creek by the specific name given to the plant.

That the possession of teeth cannot be regarded as conclusive against this being a Ficus is shown by the existence of many dentate species, both living and fossil, including the best known species of all, *F. Carica*, the fig tree proper, and M. Gaudin has described a fossil state of this species from the diluvial travertines of Tuscany which presents a nervation strikingly similar, in some respects, to the leaves under consideration (cf. Contr., IV, pl. iv, figs. 1–4).

While it does not seem possible to find any forms, either living or fossil, that combine all the characters of these leaves, there are several genera outside of Ficus which sometimes exhibit some one of them. The general form, for example, is not unlike that of Grewia (cf. Heer, Fl. Tert. Helv., pl. cix, Figs. 12, 12*b*, 12*c*; pl. cx, Figs. 1–13), but here the nervation is strictly palmate and the primary nerves all proceed from one point at the summit of the petiole. The dichotomous behavior of the secondary nerves in our leaves is closely imitated by *Grewiopsis Haydenii* Lx. (Cret. Fl., pl. iii, Fig. 4), also by some Viburnums (cf. *V. Schmidtianum* Heer, Fl. Foss. Arct., Vol. V, Pt. III, Prim. Fl. Foss. Sachal., pl. xi, Figs. 9, 10). The very thick base of the midrib, rapidly parting with its fibers to the numerous lateral nerves crowded together there as well as some other characters, best shown in Fig. 6, is not unlike Newberry's still unassigned *Phyllites carneosus* (Illustrations of Cret. and Tert. Plants, pl. xxvi, Figs. 1, 2). These characters also remind us of Credneria and Protophyllum. Finally the peculiar one-sidedness of some of these leaves and the consequent dissimilarity of the nervation resemble Saporta's *Alnus sporadum Phocœnsis* (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IX, pl. ii, fig. 5).

ULMUS L.

The Clear Creek beds contained leaves of this genus scattered very sparingly among those of Viburnum. Though few in number, they are different in form both from one another and also from any other forms that have been described in a fossil state. I have been compelled to regard them all as new and to group them under four different specific heads.

Ulmus planeroides, n. sp.

Plate XXIII, Figs. 1, 2.—Clear Creek, Montana.

Leaves ovate-lanceolate, 2.3cm. wide, 5 to 8 cm. long, pointed, oblique at the base, sharply and somewhat doubly crenate-dentate to near the base, unequal-sided; midrib straight or slightly curved; secondary nerves approximate and parallel, thirteen to seventeen on each side, making an angle of 50° to 60° with the midrib, slightly curving upward near the margin, terminating near the teeth, simple or once or twice forking near their extremities, the branches from the lower side smaller and proceeding to the sinuses, intermediate branches occasionally entering the subordinate teeth; nervilles very faint, percurrent, forked, or irregular and broken, often proceeding from the midrib as light intercalary nerves.

Of this species three specimens have been thus far found in the collection, two of which are figured. The petiole is wanting in all the specimens, and the point is preserved in only one (Fig. 2), where it is obtuse. The base is preserved in the specimens figured and is identical in both. They differ, however, considerably in length and in the num-

ber of secondary nerves, but this is not regarded as a specific distinction.

Ulmus Californica Lx. (Foss. Pl. Aurif. Gravels, pl. iv, figs. 1, 2; Cret. and Tert. Fl., pl. xlvB, fig. 3) has somewhat the same form of leaf as our specimens, but the nervation differs in the simpler secondaries, while the dentation is not at all double. In *U. discerpta* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. VIII, pl. vi, fig. 4) the dentation and the nervation are similar, but the form, so far as can be gathered from the figure of the incomplete specimens found at the Bois d'Asson, is quite different.

Ulmus minima, n. sp.

Plate XXIII, Figs. 3, 4.— Clear Creek, Montana.

Leaves lanceolate or linear, very small (6 to 10mm. wide, 2 to 3cm. long), slightly curved and one-sided, simply or somewhat doubly serrate, oblique at the base; midrib curved; secondary nerves nearly all opposite, about ten pairs, short, parallel, forming an angle of 50° with the midrib, more or less branched from the under side, the short branches running into the sinuses; nervilles indistinguishable.

Small as these leaves are they seem to have the essential characters of Ulmus and are confidently referred to that genus. Of the sixteen or eighteen living species and twenty-five or thirty fossil ones thus far known, not more than one or two are as small, and these have a greater amplitude in proportion to their length. I am therefore compelled to regard these forms as representing a new and extinct species. The fragment figured by Lesquereux, from Middle Park, Colorado, under the name of *Rhus Evansii* (Tert. Fl., pl. l, fig. 4) approaches our form very closely, but lacks the tertiary nerves going to the sinuses, characteristic of Ulmus, which might have merely been indistinguishable on the specimen. I have not had an opportunity to examine this point, as the specimen is not in the collection of the National Museum.

Ulmus rhamnifolia, n. sp.

Plate XXIII, Fig. 5.— Clear Creek, Montana.

Leaf rather large (4.7cm. wide, 9 to 10cm. long), nearly equal-sided, scarcely oblique at the base, oblong-ovate, crenate-dentate to near the base, with short and somewhat blunt, broad teeth; midrib strong, straight, diminishing very gradually towards the summit; secondary nerves numerous (twelve or more on each side), approximate, parallel, making an angle of 50° to 60° with the midrib, slightly curving upward, the two or three lowest pairs opposite, the lowest pair close to the base, simple and slender, the rest more or less branched from the under side near their extremities, the tertiaries passing into the sinuses or into intermediate teeth, which are nearly as long as those that receive the main branches; nervilles distinct, parallel, percurrent, mostly straight

and simple, sometimes forked or crossed at right angles, those from the midrib curved or bent to join the secondary below.

The petiole, upper portion, and a considerable part of the margin of this otherwise finely preserved leaf are wanting, and but for the fact that the sinuses that are shown nearly all have tertiary nerves running into them there might have been some doubt as to what genus it represented. The form and general aspect, however, as well as the nervation, are decidedly those of Ulmus.

Ulmus orbicularis, n. sp.

Plate XXIII, Fig. 6.— Clear Creek, Montana.

Leaf orbicular, large (8cm. in diameter), nearly equal-sided, irregularly doubly serrate to near the base, which is entire, horizontal, and apparently decurrent on the petiole, forming wings at its apex; midrib thick below, rapidly diminishing in passing through the leaf; secondary nerves strong (deeply furrowing the rock), close together, parallel, subopposite, leaving the midrib at an angle of 60° to 70°, much curved upward in passing across the broad parenchyma, the lowest pair sending off three to five tertiaries, the rest provided with short branches from the under side near their extremities, which enter the subordinate teeth and the sinuses; nervilles conspicuous, somewhat irregular, mostly percurrent, sometimes furcate, joining the secondaries nearly at right angles.

This enigmatic leaf-print wants the entire upper portion, but from the great curvature of the upper secondaries it seems certain that it was not attenuated at the apex, and may have even been concave or emarginate above. I am not sure that this may not have been due to a diseased state of the leaf, as I have seen cases among living plants, e. g., in Fraxinus, where, by some early injury to the normally pointed tip, it had become retuse and the abnormal growth had gone so far as to carry the upper nerves round and in toward the center at the apex, much as this leaf seems to have grown. Still the present leaf is otherwise very symmetrical, and this may well have been its normal form. The petiole is absent, but the downward curvature of the margins on both sides of the midrib at the base of the leaf seems to show that its upper portion at least was winged. The general character of its nervation and dentation is that of Ulmus, but the form is anomalous. I have failed to find either in the living or in the fossil flora any near analogues to this specimen.

LAURINEÆ.

LAURUS L.

The nervation of the leaves in the Laurineæ, while it is generally fairly characteristic of the order, often fails to distinguish the genera, and therefore considerable uncertainty must remain in many cases

where, as is usually the case, only leaf impressions exist from which to make the diagnosis. The two species which I regard as belonging to Laurus agree well enough with forms already figured and described to make it possible to refer them to such, whatever may be the doubts as to the probability that the same species thrived at such widely separated parts of the world.

Laurus resurgens Sap.

LAURUS (OREODAPHNE?) RESURGENS Sap., Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IV, p. 132, pl. vii, figs. 9A, 9B; Vol. VIII, p. 78, pl. vii, fig. 5.
DAPHNOGENE AFFINIS Sap., Examen Analytique, &c., p. 45.
OREODAPHNE? RESURGENS Schimp., Pal. Vég., Vol. II, p. 848.

Plate XXIII, Fig 7.—Bull Mountains, Montana; collected by Dr. A. C. Peale in 1883.

The finer details of the nervation in this leaf are nearly identical with those represented by Saporta in plate vii, figs. 9A and 9B, of his Flora of Armissan. In fig. 9B the midrib is somewhat curved, but not abruptly bent as in our specimen. In *Sapindus Rotarii* Mass. (Fl. Foss. del Senigal., pl. xiv, fig. 4), we have a similar form of round arches with concentrically arranged nervilles, but in this the lower secondary nerves differ from the type of the Laurineæ.

Laurus primigenia Ung.

LAURUS PRIMIGENIA Ung., Gen. et Spec., p. 423; Foss. Fl. v. Sotzka (Denkschr. Wien. Acad., Vol. II), p. 168, pl. xl, figs. 1–4; Sylloge, III, p. 72, pl. xxii, fig. 18; Foss. Fl. v. Kumi (Denkschr. Wien. Acad., Vol. XXVII), p. 55, pl. viii, figs. 1–7. Ettingshausen, Foss. Pfl. v. Heiligenkreuz bei Kremnitz (Abh. K. K. Geol. Reichsanstalt, Vol. I), p. 8, pl. ii, figs. 1, 2; Tert. Fl. Steiermark's (Sitzb. Wien. Acad., Vol. LX, Abth. I), p. 58, pl. iii, figs. 11–11c. Weber, Palæontogr., Vol. II, p. 181, pl. xx, figs. 6*a*, 6*b*. Heer, Uebersicht d. Tert. Fl., p, 55; Fl. Tert. Helv., Vol. II, p. 77, pl. lxxxix, fig. 15; Vol. III, p. 184, pl. cxlvii, fig. 10*c*; pl. cliii, fig. 3; Proc. Acad. Nat. Sci. Philadelphia, Vol. X, 1858, p. 265; Sächs.-Thüring. Braunk. Fl., p. 7, pl. vi, figs. 12*i*, 12*k*; p. 19, pl. ix, fig. 8; Foss. Fl. of Bovey-Tracey (Phil. Trans. Roy. Soc. London, 1862), p. 1062, pl. lxv, fig. 6; Braunk. Fl. d. Zsily-Thales, p. 16, pl. iii, figs. 4, 5, 6; Fl. Foss. Arct., Vol. VI, Pt. II (Nachtr. Foss. Fl. Grönlands), p. 12, pl. iii, figs. 8*a*, 9–13. Sismonda, Pal. Terr. Tert. du Piémont (Mem. R. Accad. Sci. di Torino, Ser. II, Vol. XXII, 1865), p. 438, pl. ix, fig. 2*c*; pl. x, fig. 5. Saporta, Études, Ann. Sci. Nat., Bot., 4e Sér., Vol. XIX, pp. 20, 56; pl. vi, figs. 5, 5A; 5e Sér., Vol. III, p. 93, pl. iii, figs. 8, 8A; Vol. IV, p. 126, pl. vii, fig. 7; Vol. IX, p. 38, pl. iv, figs. 7, 8; Monde des Plantes, p. 384, fig. 116, Nos. 1–3. Engelhardt, Fl. d. Braunk. im Sachsen (Preisschr. Jablonowsk. Ges. 1870), p. 20, pl. v, fig. 3; Foss. Pfl. v. Tschernowitz (Nov. Act. L.-C. Acad., Vol. XXXIX), p. 382, pl. xxiii, fig. 5; Foss. Pfl. v. Grasseth (op. cit., Vol. XLIII), p. 300, pl. xvi, figs. 4, 5; Tert. Fl. Leitmeritz. Mittelgebirges, p. 360, pl. xvii, figs. 5–7; p. 382, pl. xxi, fig. 5; p. 405, pl. xxvi, fig. 9. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1872, p. 406; Tert. Fl., p. 214, pl. xxxvi, figs. 5, 6, 8. Schimper, Pal. Vég., Vol. II, p. 818. Marion, Pl. Foss. de Ronzon (Ann. Sci. Nat., Bot., 5e Sér., Vol. XIV), p. 348, pl. xxii, fig. 19. Velenowsky, Fl. v. Vrsovic, p. 30, pl. v, figs. 1–5. Pilar, Fl. Foss. Susedana, p. 68, pl. ix, fig. 5; pl. x, fig. 8.

Plate XXIII, Figs. 8–10.—Carbon Station, Wyoming (Fig. 8). Point of Rocks, Wyoming; white sandstone bed east of station (Figs. 9, 10).

These specimens represent two of the forms which this polymorphous species assumes. The Carbon specimen (Fig. 8) is identical in form with those figured by Heer from the Zsily-Thal (pl. iii, figs. 4–6; cf., also, Saporta, Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IX, pl. iv, figs. 7, 8), while the Point of Rocks specimens (Figs. 9, 10) belong to the section of Ettingshausen's *L. phœboides* (Foss. Fl. v. Wien, p. 17, pl. iii, fig. 3), agreeing even still more exactly with the specimens from St. Jean de Garguier (Ann. Sci. Nat., Bot., 5e Sér., Vol. III, pl. iii, fig. 8). These latter constitute an addition to the already so well worked white sandstone bed at Point of Rocks.

It is not difficult to find many analogues of these elongated leaves belonging to widely different families of plants, and among such *Eugenia Hæringiana* Ung. (Sylloge, III, pl. xviii, figs. 8, 9), *Callistemophyllum melaleucæforme* Ett. (Foss. Fl. v. Bilin, III, pl. liv, figs. 1–3), *Hippophaë striata* Ludw. (Palæontogr., Vol. VIII, pl. xliv, fig. 4), and *Apocynophyllum lanceolatum* Ung. (Foss. Fl. v. Sotzka, pl. xliii, figs. 1, 2) simulate our leaves more or less both in form and nervation. The Carbon specimen may also be compared with some other species of Laurus, as, e. g., with *L. Canariensis pliocenica* Sap. (Vég. Foss. de Meximieux, pl. xxvii, fig. 6), and also with other lauraceous forms, such as *Tetranthera sessiliflora* Lx. (Tert. Fl., pl. xxxv, figs. 8*a*, 9).

Baron von Ettingshausen considers Fig. 9 as corresponding more closely to *L. ocoteæfolia* Ett. and the others as belonging to an allied species rather than to *L. primigenia*. The forms would thus embrace two new species.

LITSÆA Lam.

The nervation of this genus, which now includes Tetranthera, is very similar to that of Laurus, but still nearer to that of Ocotea (Oreodaphne Nees) and Persea. Our forms, of which only one is figured, may belong to one of the latter almost as well as to Litsæa.

Litsæa Carbonensis, n. sp.

Plate XXIV, Fig. 1.—Carbon Station, Wyoming.

Leaf lanceolate, 5cm. broad, somewhat abruptly taper-pointed, entire, with slightly irregular or wavy margins; midrib strong, flexuous above; lateral primary nerves ascending and approaching the margins above the middle, anastomosing with the first pair of secondaries, which are separated from them on the midrib by a long internode and proceed at a much greater angle (40°); secondaries only two on each side, the first pair nearly opposite, the upper pair alternate, making an angle of 60° with the midrib, joined near their extremities by those from below; nervilles joining the midrib and primaries to one another and to the secondaries, usually curved or geniculate, often forked, joined, or crossed by veinlets, meeting them at different angles.

This species closely resembles *Tetranthera præcursoria* Lx. (Cret. and

Tert. Fl., pl. xlviii, fig. 2), from the Bad Lands of Dakota, but as in that specimen the summit was wanting and the base preserved, while in ours the base is wanting and the summit preserved, it is not possible to institute a thorough comparison. In that figure, however (the specimen I have not seen), there are three pairs of opposite secondary nerves, and the lateral primaries are drawn much more slender than they are in the Carbon plant, and from the part preserved it seems probable that the summit of that leaf was much shorter-pointed. Perhaps an even closer approximation to our leaf occurs in *Oreodaphne Heerii* Gaud. (Gisements, Nouv. Mém. Soc. Helv., Vol. XVI, pl. x, fig. 7; reproduced in Saporta, Vég. Foss. de Meximieux, pl. xxvi, fig. 9), though here also the point is much less slender and no sign of the characteristic glands at the base of the lateral nerves is visible in our specimen.

CINNAMOMUM Blume.

An almost exclusively tropical genus, embracing about fifty species, confined to the Old World, but ranging on both sides of the equator. Fossil representatives are abundant in the Tertiaries of Europe, especially in the Eocene, but forms are reported as low as the Cenomanian. The four species of the Laramie thus far described argue a warm climate.

Cinnamomum lanceolatum (Ung.) Heer.

CINNAMOMUM LANCEOLATUM (Ung.) Heer, Fl. Tert. Helv., Vol. II, p. 86, pl. xciii, figs. 6–11; Foss. Fl. Bovey-Tracey (Phil. Trans. Roy. Soc. London, 1862), p. 1063, pl. lxvii, figs. 1–8, pl. lxviii, figs. 14, 15; Braunk. Pfl. v. Bornstädt (Abh. Naturf. Ges. z. Halle, Vol. XI, 1869), p. 16, pl. iii, figs. 2*a*, 2*c*; Mioc. Balt. Fl., p. 77, pl. xxii, figs. 14–17; Braunk. Fl. d. Zsily-Thales, p. 17, pl. iii, fig. 3. Massalongo, Synops. Fl. Foss. Senog., p. 62; Fl. Foss. del Senigal., p. 265, pl. viii, figs. 2, 3, 4; pl. xxxiii, fig. 9. Ludwig, Palæontogr., Vol. VIII, p. 109, pl. xliii, figs. 1–7. Saporta, Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IX, 1868, p. 40, pl. iv, figs. 11–16. Sismonda, Pal. Tert. du Piémont, p. 440, pl. xxiv, figs. 5, 6; pl. xxvi, fig. 7. Unger, Foss. Fl. v. Kumi (Denkschr. Wien. Acad., Vol. XXVII), p. 54, pl. vii, figs. 1–10. Ettingshausen, Foss. Fl. d. Wetterau (Sitzb. d. Wien. Acad., Vol. LVII, Abth. I), p. 850, pl. iii, figs. 4, 5; Foss. Fl. v. Bilin, II (Denkschr. Wien. Acad., Vol. XXVIII), p. 198, pl. xxxiii, figs. 7–9, 13, 16, 16*b*. Engelhardt, Fl. d. Braunk. Sachsen (Preisschr. Jablonowsk. Ges., 1870), p. 20, pl. iv, figs. 11, 12; Cyprissch. Nordböhm. (Sitzb. Naturw. Ges. Isis, 1879), p. 10, pl. vii, figs. 22, 23; Foss. Pfl. v. Grasseth (Nov. Act. L.-C. Acad., Vol. XLIII), p. 304, pl. xii, figs. 11, 14, 15; pl. xiii, figs. 10, 12; pl. xviii, figs. 1–5. Schimper, Pal. Vég., Vol. II, p. 842. Lesquereux, Tert. Fl., p. 219, pl. xxxvi, fig. 12. Pilar, Foss. Fl. Susedana, p. 61, pl. xi, figs. 2, 4, 12, 14?, 15.

PHYLLITES CINNAMOMEUS Rossm., Verstein., p. 23, pl. i.

DAPHNOGENE LANCEOLATA Ung., Gen. et Spec., p. 424.

Plate XXIV, Fig. 2.—Hodges Pass, Wyoming.

Notwithstanding the fact that only two doubtful specimens, Nos. 315 (Lesquereux, Tert. Fl., p. 219, pl. xxxvi, fig. 12) and 790 of the National

Museum collection, have to my knowledge been thus far found in American strata, I nevertheless was compelled to refer this form to that species on account of its great general resemblance to so many of the European specimens. As Prof. Lesquereux's specimens were found at Evanston and as I have considered the Hodges Pass beds as a northern extension of the Evanston coals, the discovery of the same form at both places is not perhaps surprising. It must, however, be admitted that our plant differs from all others thus far published in its greater length and size. Although wanting the summit there are 11 centimeters of it still preserved, and the specimen indicates that the leaf must have been nearly or quite 15cm. long, while its width is about 2.5cm. Rossmässler's original specimen, as reconstructed at the base by himself (Verstein., pl. i, fig. 2), and which is one of the largest figured anywhere, is 11cm. long by 2.8cm. wide. The Evanston specimens indicate a leaf not more than 8 or 10 cm. long. In most other examples, too, the lateral primaries are exactly opposite, which is not the case here, though they are nearly so. Otherwise there is no material divergence in the nervation, so far as it is exhibited in the specimen, but as the matrix in which it was embedded is a very coarse sandstone the finer details of nervation are not visible and only a very few nervilles can be made out. The Marquis Saporta, to whom figures were sent, is therefore doubtless correct in regarding this as a distinct species.

? Cinnamomum affine Lx.

? CINNAMOMUM AFFINE Lx., Am. Journ. Sci., 2d Ser., Vol. XLV, 1868, p. 206; Ann. Reps. U. S. Geol. Surv. Terr., 1867, 1868, 1869, p. 196; 1870, p. 383; 1872, 383, 387; 1873, p. 401; Tert. Fl., p. 219, pl. xxxvii, figs. 1-5, 7; Cret. and Tert. Fl., p. 252, pl. lviii, fig. 9.

Plate XXIV, Figs. 3-5.—Black Buttes Station, Wyoming.

So referred in the Sixth Annual Report, pl. xlvii, figs. 1-3, but Prof. Lesquereux would refer them to Ficus and not to Cinnamomum. They would then fall into the section with *F. planicostata* Lx., but after examining a large number of unfigured specimens of that species and its varieties, as well as of *F. spectabilis* in connection with the types and figures, I conclude that the species is new.

There are in the Museum collection a number of unfigured specimens (Nos. 312 *a*, *b*, *c*) of *Cinnamomum affine*, from Point of Rocks, Wyoming, at least one of which (312*b*, Lesquereux's private number 1499) has the lateral primaries joined to the margins below the abrupt expansion of the blade, precisely as in our Fig. 1. These must be specifically identical with the Black Buttes specimens, to whatever genus it be thought proper to refer them.

There is considerably more material in the collection, and after it has all been more thoroughly studied and figured more light will probably be thrown upon the affinities of this plant.

DAPHNOGENE Ung.

This genus is only provisional, no fruits having as yet been discovered. Eighteen species are retained by Schimper in his Paléontologie Végétale.

Daphnogene elegans Wat.

DAPHNOGENE ELEGANS Wat., Pl. Foss. de Paris, p. 180, pl. li, figs. 5, 6. Saporta, Fl. Foss. de Sézanne, p. (80) 368, pl. (viii) xxix, fig. 11. Schimper, Pal. Vég., Vol. II, p. 851.

Plate XXV, Fig. 1.—Black Buttes Station, Wyoming.

The only important difference that separates this specimen from the only other two known, as described and figured in the works cited, is the smaller angle which the secondary nerves make with the midrib. As none of the authors regard the generic reference as at all settled and as our leaf doubtless belongs to the Laurineæ, it is perhaps as well to leave it here until better material shall justify a change.

MONIMIACEÆ.

MONIMIOPSIS Sap.

The genus Monimia, from the resemblance to which certain fossil forms have been called by this name, is confined, so far as known, to the Mascarene Islands of the Indian Ocean and embraces only three species, but two fossil species from Hæring in Tyrol (Oligocene) have been referred to it. To the extinct genus three species are referred by Saporta, all from the Paleocene of Sézanne. It would be something of a confirmation of the alleged homotaxy of the Laramie group with this Paleocene flora if undoubted specimens of these species should be found to occur in it. This, however, is not claimed for the two following forms.

? Monimiopsis amboræfolia Sap.

? MONIMIOPSIS AMBORÆFOLIA Sap., Foss. Fl. de Sézanne, p. (73) 361, pl. (viii) xxix, fig. 13. Schimper, Pal. Vég., Vol. II, p. 765.

Plate XXV, Fig. 2.—Seven Mile Creek, Montana; Sapindus bed.

Except in size this specimen agrees remarkably well with that of Saporta, far better than with anything else with which I have thus far been able to compare it either in the fossil or in the living flora, and this mere difference of size, especially where so few specimens are known, cannot be regarded as specific. The base of our leaf is more oblique and there is a sort of notch in the border on one side, but the latter probably represents a natural defect not common to other leaves of the species. The improbability that a species should have such a wide range is the chief objection to the reference made.

For analogues in other families bearing more or less resemblance to this leaf, see *Euonymus Proserpinæ* Ett., Foss. Fl. v. Bilin, III (Denkschr. Wien. Acad., Vol. XXIX), pl. xlviii, figs. 6, 7; *Celastrus fraxini-*

folius Lx., Cret. and Tert. Fl., pl. xl, fig. 10; *Juglans alkalina* Lx., Tert. Fl., pl. lxii, figs. 6, 7; and even *Alnus cardiophylla* Sap., Fl. Foss. de Sézanne, pl. (xv) xxxvi, fig. 8.

? Monimiopsis fraterna Sap.

? MONIMIOPSIS FRATERNA Sap., Fl. Foss. de Sézanne, p. (74) 362, pl. (viii) xxix, fig. 14. Schimper, Pal. Vég., Vol. II, p. 765.

Plate XXV, Fig. 3.—Seven Mile Creek, Montana; bed below the ironstone.

Most of what was said of the last species will apply also to the present one. The Laramie specimen is more nearly complete in outline, but much of the border is unfortunately wanting. It is, however, preserved below on one side and above on the other so that the general character of the marginal nervation can be safely inferred for the whole leaf. Still more important is the almost complete preservation of the point which is wanting in the Sézanne leaf. The body of the leaf is well preserved and the characteristic arches with tertiary veins springing from them are distinctly shown. In one case where the margin is preserved a secondary nerve appears to reach the blunt tooth directly, and others may be assumed to have done so. Three pairs of lateral nerves are approximate near the base, alternate and more erect than in Saporta's figure, while above these a long interval occurs, giving to the third pair, which are considerably stronger than the rest, somewhat the character of primary nerves of a palmately nerved leaf. In these somewhat relative characters our specimen deviates from the European, and this divergence may be specific or even generic.

In *Viburnum rugosum pliocenicum* Sap. (Pl. Foss. de Meximieux, pl. xxxi, fig. 1) the form of the upper portion of the leaf is very similar and the peculiar arching of the uppermost secondaries strikingly so, but the lower secondaries are all alternate and scattered somewhat evenly along the midrib. The margin, too, is nearly undulate, and the areolæ formed by the nervilles are of an entirely different character from those of our leaf and of the Monimiaceæ. Other analogues are *Styrax vulcanicum* Ett. (Foss. Fl. v. Bilin, II, Denkschr. Wien. Acad., Vol. XXVIII, pl. xxxix, fig. 13) and *Tetrapteris Bilinica* Ett. (loc. cit., III, op. cit., Vol. XXIX, pl. xlvi, fig. 11).

POLYPETALÆ.

CORNACEÆ.

NYSSA L.

This small genus of only five or six species is restricted in the present flora to the eastern portions of North America and of Asia. About twenty species have been described in the fossil state either from leaves or from fruits. Most of these are from Miocene deposits, such as the

brown coal of the Wetterau and of Samland on the Baltic, Styria, Sused, Bonn, Quegstein, &c., on the continent, Bovey-Tracey, and numerous arctic localities, including Alaska. Within the territory of the United States we have several of the fossil fruits of Brandon, Vt., referred to that genus, and one species (*N. lanceolata* Lx.) represented, according to Lesquereux, by both leaves and fruits from the Laramie group at Golden, Colo., and by leaves from near Fort Ellis, Montana. Newberry's *N. vetusta* is referred by Lesquereux to *Magnolia alternans* Heer (see National Museum catalogue, No. 702).

Nyssa Buddiana, n. sp.

Plate XXV, Fig. 4.—Hodges Pass, Wyoming; named in honor of Mr. J. Budd, superintendent of construction of the Oregon branch of the Union Pacific Railroad, who directed me to this locality.

Leaf ovate-lanceolate, 4.5cm. wide, about 12cm. long, entire but gently wavy margined; midrib slightly sinuous below, as thick as the slender petiole, nearly uniform through the leaf, secondary nerves alternate, about fourteen on a side, issuing from the midrib at a wide angle (60°), inequidistant, the wider intervals occupied by one or sometimes two intercalary nerves, which either end blind or join the nervilles; principal secondaries curving upward near the margin after giving off from the under side one or two tertiary nerves, which pass downward and anastomose with the secondaries below, forming arches or loops from which smaller veinlets pass outward toward the margin, but become indistinguishable before reaching it; nervilles indistinct, apparently irregular.

If it may be said that these characters in the nervation are largely those of Magnolia, the answer is that in so far they are common to the two genera, for they are all present in at least two species of Nyssa of the living flora of eastern North America (*N. multiflora* Wang. and *N. uniflora* Wang.), both of which, as well as *N. Caroliniana* Walt. and *N. aquatica* L., I have carefully compared with this fossil. But the nervation of Nyssa is distinguished from that of most Magnolias by a certain irregularity in the secondaries, by the occurrence of intercalary nerves (at least in some species), and especially by the rapid diminution of the smaller veinlets, so as to make them seem to vanish or end blind.

The specimen was badly crumpled in its coarse sandstone matrix before this had hardened, but nevertheless the silicified substance of the leaf remains and coats the rock with a dark layer, in which the position of the nerves is distinctly laid down, the two counterparts complementing each other to considerable extent. The leaf was thick and coriaceous and the petiole, of which about 2 centimeters are preserved, is bent in a short angle below the blade, probably by extraneous agencies after falling from the tree.

Of the fossil forms referred to Nyssa our specimen most resembles those from Liescha (Zwanziger, Mioc. Fl. v. Liescha, pl. xxii). The

form of the leaf is not unlike that of some species of Diospyros (cf. Heer, Mioc. Balt. Fl., pl. xxvii), and Ettingshausen's *Tabernæmontana Bohemica* (Foss. Fl. v. Bilin, II, pl. xxxvi, fig. 17) approaches it quite closely both in shape and nervation.

CORNUS L.

This genus consists, in the living flora of the globe, of about twenty-five species, no less than eighteen of which are natives of North America. It is therefore not to be wondered at that fossil remains of it should be found in American strata. Thus far four species have been reported from the Laramie group, one of which, *C. acuminata* Newberry (*C. Nebrascensis* Schimp.), is from the Fort Union deposits. This paucity is made up by the occurrence of a considerable number in the arctic fossil flora, three of which are from the Cretaceous.

Thus far only three species have been detected in my collections, two of which are from the lower districts and one from the Yellowstone Valley.

? Cornus Fosteri, n. sp.

Plate XXV, Fig. 5.—Upper Seven Mile Creek, 10 miles above Glendive, Montana; collected by Mr. Richard Foster, of Dr. White's party, in 1882.

Leaf ovate, entire with slightly uneven margins, rounded and oblique at the base, 8cm. wide, 15cm. long; nervation pinnate, camptodrome; midrib thick below, more slender and somewhat sinuous above; secondary nerves about ten on each side, nearly opposite below, alternate above, the lower ones more approximate than the upper, basal pair thin and parallel to the margin, second and third pairs strongest, proceeding from the midrib at an angle of 50°, and curving upward in passing out toward the margin, branching near their extremities from the under side, arching and anastomosing with the branches of the next higher, the uppermost more erect and somewhat acrodrome; nervilles indistinct, chiefly percurrent, parallel, joining the secondaries at right angles.

It seems probable that the reference of this leaf to Cornus was an error, although the acrodrome tendency of the uppermost secondaries is a good index to that genus. Still, the lower lateral nerves show too little of this acrodrome tendency and follow more nearly the character of Ficus, and the nervilles are also those of Ficus rather than of Cornus. But for the simple percurrent nervilles the resemblance to Populus would be very close (cf. *P. monodon* Lx., Tert. Fl., pl. xxiv, fig. 2; *P. hyperborea* Heer, Fl. Foss. Arct., Vol. III, Pt. II, Kreidefl., pl. xxix, fig. 6). In form it resembles the figure last cited more closely than any other I have been able to find. Upon the whole, however, I now incline to regard it as a Ficus and as having as its nearest affinity *F. spectabilis* Lx. (Tert. Fl., pl. xxxiii, figs. 4–6).

I did not visit this locality. The specimens obtained from there the previous year are all in a coarse sandy ironstone. They show little of the more detailed nervation, but the principal nerves are usually deeply impressed in the rock. In this specimen, however, we have only the under surface of the leaf with the nerves well in relief. The lower and thicker part of the midrib is channeled in the specimen, but it is evident that this is due to its imperfect preservation, the epidermis and central fibers having disappeared, leaving a groove. The upper part of the leaf was rolled in so that it was necessary to break it out and represent it as if unrolled. Although this was very skillfully and successfully done by Mr. Everett Hayden, there still remains a considerable part, including the point and most of one side, unrepresented.

Cornus Studeri Heer.

CORNUS STUDERI Heer, Uebersicht der Tertiärflora, p. 58; Fl. Tert. Helv., Vol. III, p. 27, pl. cv, figs. 18–21; Fl. Foss. Arct., Vol. V, Pt. III (Prim. Fl. Foss. Sachal.), p. 45, pl. xi, figs. 11–13. Ludwig, Palæontogr., Vol. VIII, p. 121, pl. lviii, fig. 10. Lesquereux, Tert. Fl., p. 244, pl. xlii, figs. 4, 5. Schimper, Pal. Vég., Vol. III, p. 52.

Plate XXVI, Fig. 1.—Point of Rocks, Wyoming; gray sandstone bed north of station.

If we really have in this specimen a leaf of *Cornus Studeri* our knowledge of that species is thereby considerably extended, as none of the specimens thus far figured has the petiole preserved. Our leaf, however, differs in two respects from most of the species of Cornus known, whether living or fossil, namely, in its thicker midrib, especially below, and in its nervilles, which form nearly a right angle with the nerves they join. In all the living species of Cornus that I have examined, which include all the American species and several European, the nervilles pass across the areas formed by the lateral nerves in a horizontal direction or nearly at right angles to the midrib. In Heer's largest specimen they are represented as slightly ascending. In many respects all the American specimens referred to this species resemble Ficus and its closest allies (cf. *F. artocarpoides* Lx., Cret. and Tert. Fl., pl. xlvii, fig. 1, and *Artocarpoides conocephaloidea* Sap., Fl. Foss. de Sézanne, pl. xxvii, fig. 6), and it may still be considered a question to what genus they belong.

Cornus Emmonsii, n. sp.

Plate XXVI, Figs. 2, 3.—Golden, Colo. (Fig. 2); collected for Mr. S. F. Emmons by C. W. Cross, in July, 1882. Point of Rocks, Wyoming; gray sandstone bed north of station (Fig. 3).

Leaves oblong, 4.5 to 5cm. wide, 7 to 8cm. long, rounded at both base and summit; nervation pinnate, camptodrome; midrib rather thick, visibly diminishing at each node, slightly zigzag; secondary nerves eight to nine on a side, large at their point of insertion, rapidly thinning out, the lower nearly opposite, lowest pair very light and close

to the margin, which they follow a long distance, the remainder nearly equal, making an angle with the midrib of 40° to 50°, second pair giving off several short tertiaries, which curve forward slightly in crossing the narrow area to join the basilar nerves, the rest having fewer tertiaries near their extremities, which join the incurved ends of the next nerves below them and also join one another, forming loops and arches near the margin, the upper secondaries acrodrome, curving rapidly inward at the obtuse or obcordate summit of the leaf; nervilles indistinct wavy, or bent, percurrent, or forked.

Notwithstanding the widely separated localities from which these specimens come, they present so many points of resemblance that I am unable to assign them to different species. The Golden specimen, which is from the tufa beds, is less perfectly preserved, the black glaze which once represented the lamina having been worn off, probably since its collection, from a considerable part of it; the margins, too, are difficult or impossible to make out, except for a limited part of the way round. The Point of Rocks specimen is in hard rock and shows the substance of the leaf by the deposit of a much darker coloring matter. In all that is preserved the nervation and margins are distinctly shown. The upper portion bears every indication of having been slightly depressed after the manner of certain forms of *Liriodendron Meekii* Heer, with which I was long disposed to associate it. The nervation, however, is decidedly characteristic of Cornus and appears to be identical with that of the Golden plant.

This species probably has its nearest analogue in *C. orbifera* Heer, especially as it occurs at the Bois d'Asson (Saporta, Études, Ann. Sc. Nat., Bot., 5e Sér., Vol. VIII, 1857, pl. xiii, fig. 3), but it also bears a strong resemblance to *C. impressa* Lx. (Tert. Fl., pl. xlii, fig. 3).

ARALIACEÆ.

HEDERA L.

Although only two species of this genus now exist, and only one in the northern hemisphere, there is reason to suppose that during Cretaceous and Tertiary time it played an important rôle in the vegetation of the globe. Five Cretaceous and twelve Tertiary species are described in the various works, four of which latter, however, are Pliocene, and may not be more than so many diverse forms of the intermediate ancestor of the present Old World species, *H. Helix* L. Of the Cretaceous species one, *H. primordialis* (Sap.) Heer, is common to the Cenomanian of Bohemia and of Greenland; another (*H. cuneata* Heer) is common to the Cenomanian and the Cenomanian strata of Greenland. [illegible] species occur in the flora of the Dakota group. Of the Tertiary [illegible] is from the Eocene of Ai[illegible] Arctic and high [illegible] are found on the continen[illegible]

We should not therefore be surprised to find representatives of this genus in Laramie strata, although thus far none have been reported. If the four following forms have been correctly assigned we have examples from both the lower and the upper districts.

Hedera parvula, n. sp.

Plate XXVI, Fig. 4.—Clear Creek, Montana.

Leaf orbicular, small (2.2cm. in diameter), emarginate at the apex, faintly sinuate on each side near the summit, otherwise entire; nervation palmate, camptodrome; primary nerves seven, all issuing from near the base but not from the same point, median nerve (midrib) strongest, bearing four or five alternate erect branches; the six lateral ones opposite in pairs; lowest pair basilar, giving off short branches from the under side; second pair more erect (40°), dividing up somewhat dichotomously; third pair strongest, very erect (20°), forking two or three times, the upper branches becoming parallel to the midrib or slightly acrodrome; ultimate ramifications arching and anastomosing near the margin; nervilles indistinct, mostly percurrent and perpendicular to the nerves joined.

The nervation is here essentially identical with that seen in *H. primordialis* (Sap.) Heer (Fl. Foss. Arct., Vol. VI, Abth. II, Foss. Fl. Grönld., pl. xxiv, fig. 6*a*) and in some respects resembles that of *H. ovalis* Lx. (Cret. Fl., pl. xxv, fig. 3; pl. xxvi, fig. 4).

Hedera minima, n. sp.

Plate XXVI, Fig. 5.—Head of Clear Creek, Montana.

Leaf very small, as broad as long (17mm.), broadly truncate at the summit, cuneate at the base, somewhat pentagonal in outline, short petioled; nervation palmate, camptodrome, somewhat brochiodrome; primary nerves five, nearly equal, slender, all rising from the same point at the summit of the petiole; the two lower spreading and parallel to the margin, branched above; the second pair very erect (20°), curving upward and inward toward the apex of the leaf (acrodrome), giving off tertiary nerves from the outer side; median nerve (midrib) rather lighter than the lateral nerves, slightly flexuous, nearly simple; nervilles indistinguishable.

This small leaf is preserved nearly complete, including a short petiole 3 millimeters long, which does not seem to show the point of insertion. Its peculiar somewhat angled or trapezoid outline is strongly suggestive of Hedera, while the nervation is not unlike that of that genus. The reference, however, is less certain than in the last species. It somewhat resembles *Cercis parvifolia* Lx. (Cret. and Tert. Fl., pl. xxxi, figs. 5–7), from Florissant, and perhaps still more *Paliurus orbiculatus* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IX, 1868, pl. vii, fig. 6), which has also been found at Florissant (Lesquereux, Cret. and Tert. Fl., pl.

xxxviii, fig. 12). The erect acrodrome character of the upper lateral nerves also simulates some of the arctic species of Populus.

Hedera Bruneri, n. sp.

Plate XXVI, Fig. 6.—Black Buttes Station, Wyoming.

Leaf large, compressed-dilate, 10cm. wide, 7cm. long (exclusive of the petiole, which is 6cm. long, thick, and dilated at both extremities), entire at the base, sinuate-toothed from below the middle; nervation strongly palmate, craspedo-camptodrome, three strong primary nerves rising from the enlarged summit of the petiole carrying all its fibers; central nerve largest, giving off from above the middle five or six alternate secondary nerves and rapidly diminishing to the apex; lateral nerves diverging at an angle of 40° from the midrib and slightly curving upward, each giving off somewhat dichotomously about five secondaries from the outer side, one of these largest and sending out tertiaries, the rest branching or forking towards their extremities, the branches uniting in angled arches, from which smaller veinlets proceed to or near the margin; nervilles obscure, bent, or forked, often appearing to end blind.

The greater part of the margin of the otherwise well preserved leaf is wanting above, but in a few places the short rounded teeth can be distinguished. The specimen was found lying on the surface and was slightly weather worn, but the lower portions had to be chipped out and are shown very clearly. Over the whole of the blade are scattered loose grains of silex, which are cemented firmly to the rock and cannot be removed without injury to the specimen, but these do not seriously obscure the nervation.

This singular leaf is clearly unlike any others that have been collected in the West. I long inclined to regard it as a Populus (cf. *P. mutabilis* Heer, Fl. Foss. Arct., Vol. VII, pl. lxxxix, fig. 7), and it certainly has some points in common with the leaf I have called *P. hederoides* (Pl. VIII, Fig. 5), as also with *P. amblyrhyncha* (Pl. VI and VII), but the absence of true basilar nerves and the dichotomous character of the nervation seem positively to exclude the present specimen from that genus. It has some analogy with Menispermites (cf. Lesquereux, Cret. and Tert. Fl., pl. xv, fig. 1), though here the leaves are cordate or peltate, and it resembles some forms of Vitis and Cissites (cf. op. cit., pl. iii, fig. 3; pl. v, figs. 2–4; Saporta, Fl. Foss. de Sézanne, pl. x, fig. 10; Heer, Fl. Foss. Arct., Vol. VII, pl. xxi, fig. 8). But after examining various forms of Hedera figured from the American Cretaceous (cf. *H. platanoidea* Lx. (Ann. Rep. U. S. Geol. Surv. Terr., 1874, p. 351, pl. iii, figs. 5, 6), from Sézanne (cf. *H. prisca* Sap., loc. cit., fig. 1), and especially from Spitzbergen (cf. *H. McClurii* Heer, Fl. Foss. Arct., Vol. II, Pt. III, Mioc. Fl. Spitzb., pl. xiii, figs. 29–33; Vol. IV, Pt. I, Beitr. Foss. Fl. Spitzb., pl. xviii, figs. 1, 2), it was impossible to doubt that it

is here that this form properly belongs. I am satisfied, however, that it is none of the species referred to, and I therefore take pleasure in naming it after my esteemed friend and companion during that season's campaign, Prof. Lawrence Bruner.

Hedera aquamara, n. sp.

Plate XXVI, Fig. 7.—Black Buttes Station, Wyoming.

Leaf obovate-cuneate, 3cm. wide, 6cm. long, irregularly sinuate-dentate above, nearly entire below; nervation pinnate, craspedo-camptodrome; midrib flexuous and somewhat zigzag; secondary nerves four to five on each side, alternate, very erect (20° to 30°), irregular, mostly terminating in the teeth of the upper part of the leaf, the lower ones closely following the margins below, the upper somewhat branching, the branches anastomosing with one another and sending off short veinlets which curve very near the margins, forming a marginal row of small arches; nervilles very prominent and shading insensibly into the true tertiary nervation, irregularly branching and intercrossing to form very fine quadrilateral or polygonal meshes.

I was at first disposed to regard this fossil as an oak leaf, and there are many points that favor that view, but there are others that oppose it. The secondary nerves are more erect than in any species of oak with which I am acquainted. There is a near approach to it in *Quercus affinis* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. III, 1865, pl. iii, fig. 10), but here the general nervation is quite different. A nearer approach in all respects to our leaf is seen in *Celastrus illicinus* Burch. (Ettings., Blattsk. d. Dicotyl., pl. lxiv, fig. 2), from Van Diemen's Land, and *Telopea speciosissima* R. Br. (op. cit., pl. xxii, fig. 9), from the Cape of Good Hope, embodies many of the same characters. Nevertheless it seems to me to agree better in its general character with Hedera, and its anomalous shape may be accounted for on the assumption that the leaf belonged to a flowering branch, where, as is the habit of our living species, the leaves may have been more elongated and altered in outline from the form characteristic of the genus. The peculiar leaf from Greenland figured by Heer (Fl. Foss. Arct., Vol. II, Pt. V, pl. xlv, fig. 5*b*), which has the form and to a very great extent the nervation also of our leaf, is referred by him to his *H. McClurii*, usually so very different in form, and this reference is justified on that theory. Our plant comes from the same bed as the species last described, and may belong to it, notwithstanding the great inequality in size and difference in form. This, however, can scarcely be regarded as probable.

ARALIA L.

In referring the following forms to this genus I merely follow the precedent established in this country, as I do not consider this the proper place to open up the question as to the necessity for making a

change. That some change must soon be made I feel certain, and my own material, more than anything else I have seen, tends to force it upon us. But others are becoming aware of this necessity, and in a recent letter (Sept. 7, 1885) Prof. Lesquereux, who is now working up some new material from the Dakota group, speaking of certain forms recently referred by Engelhardt to Credneria, says: "From the reference of these leaves to Credneria we should have to put in the same group or genus the Araliopsis, Grewiopsis, Platanus, Sassafras, &c., described from the Dakota group."

I need only say, in confirmation of this, that from their close general resemblance and from intermediate forms which I have myself collected and studied, I can scarcely doubt that the forms which I here refer to Aralia belong to the same "group or genus" as those which I have referred to Platanus in the earlier part of this paper.

In view of these doubts I do not deem it necessary to attempt any justification of the generic assignment here made by considerations derived from the present range of the genus.

Aralia notata Lx.

ARALIA NOTATA Lx., Tert. Fl., p. 237, pl. xxxix, figs. 2–4; Cret. and Tert. Fl., p. 232.
PLATANUS DUBIA Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1873, p. 406.

Plate XXVII, Fig. 1.—Clear Creek, Montana.

This specimen was collected near the same spot where many other very large leaves were found, as well as some intermediate in size having substantially the same general form and character. The latter I had expected to be obliged to refer to Platanus, but whether to *P. nobilis* or to some new species I have not yet decided, not having completed their study. Many, if not all, of them have the margins entire throughout and the nervation camptodrome, as in this specimen, and I am as yet undecided as to whether this can be regarded as a specific character.

The present specimen, notwithstanding the narrower sinuses, closely resembles those figured by Lesquereux above cited, two of which (figs. 2 and 4) were collected on Elk Creek, near the Yellowstone, and probably come from Fort Union strata. Several other specimens having the same form occur in the reserve series of the National Museum, one of which (No. 922) is also from the north (near Fort Ellis, Montana). In all these the primary nerves originate at the very base of the leaf, and this is one of the chief distinctions which separate them from the forms referred to Sassafras (Araliopsis) from the Cretaceous. That those forms do not belong to Sassafras I have always felt satisfied. Only one species of Sassafras is known in the present flora of the globe and this is confined to North America. Although its leaves are very variable, the variations are definite and fall under a few types. The lobed leaves belong almost exclusively to non-flowering branches, the normal foliage showing entire leaves with a nervation of strongly marked Lauraceous type, usually re-

sembling that of Laurus or Persea, but sometimes becoming more decidedly palmate and approaching that of Cinnamomum. This type is out of the question here. The Cretaceous leaves are usually symmetrically three-lobed and the assumption would be legitimate that they represent a uniformly three-lobed ancestor which is revealed only in the non-flowering branches of our modern chiefly entire leaved species, could we find in these modern lobed leaves something very near to the nervation of this ancestor. But I could never see that we do find this. The nervation of the modern lobed leaves of Sassafras is very uniform and in some respects remarkable. From the pair of lateral primaries that go to the lobes to the next pair of nerves issuing from the midrib there is usually a long interval, partly occupied by horizontal nerves, which scarcely belong to the secondary system. The first pair of true secondaries leave the midrib at a wide angle and soon curve upward, passing directly to the middle of the large rounded sinuses. Here they are not lost, but immediately fork and follow the two margins of the sinuses, usually forming its actual border (paryphodrome) for some distance. From this hem or border they may usually be seen giving off branches or leaving it altogether and passing up farther inward to join the branches of the primaries. This character in the nervation of Sassafras is so peculiar and uniform that I am surprised that it has not been more carefully considered in connection with the fossil leaves. No such character is to be found in any of these. On the contrary the first pair of secondary nerves usually fork before reaching the sinus, the two branches striding it and passing upward at some distance from the margins. Often a branch from the lateral primary goes out to meet the one from the midrib and either joins it before reaching the sinus or, as in our present specimen, arches along the inner margin of the lateral lobe, while the branch from the midrib follows in a similar manner the margin of the terminal lobe.

Whether the ancestor of our living Sassafras will ever be found in American strata is uncertain, though a near approach to it is seen in *Aralia acerifolia* Lx. (Cret. and Tert. Fl., pl. xlix, Fig. 5), and that a true Sassafras has been found in European strata is settled by the nervation of *S. Ferrettianum* Mass., from Senegal (Fl. Foss. del Senigal., pl. xii, fig. 1), in which the character above described is clearly shown. Compare also *S. primigenium* Sap. (Fl. Foss. de Sézanne, pl. viii, figs. 9, 10; Monde des Plantes, p. 219, fig. 41).

Aralia Looziana Sap. & Mar.

ARALIA LOOZIANA Sap. & Mar., Révision de la Flore Heersienne de Gelinden (Mém. Cour. Acad. Roy. de Belgique, Vol. XLI), p. 77, pl. xiii, fig. 13. Saporta, Monde des Plantes, p. 216, fig. 37.

Plate XXVII, Fig. 2.—Clear Creek, Montana; collected by Dr. White's party in 1882.

I have not seen any work in which this species is technically described, but with the exception of being a little larger our specimen agrees so

perfectly with the figure cited above that it seems necessary to regard it as the same species. It wants the immediate base and the petiole, while the middle lobe is somewhat distorted. I did not find in the Clear Creek beds any forms precisely similar, and it seems to resemble more closely the specimens, found 9 miles farther up the valley, to be next described.

Aralia digitata, n. sp.

Plate XXVII, Figs. 3, 5; Plate XXVIII, Fig. 1.—Head of Clear Creek, Montana.

Leaves digitately three to five lobed, variable in size (6 to 18 cm. in width), entire and cuneate below, the base appendaged with a pair of short sagittate lobes, upper lobes lanceolate, as long as the body of the leaf, slightly broadened upward, rapidly narrowed to a point or merely rounded at the summit, entire to near the apex, sinuate-dentate at their extremities; petiole thick, 2.3cm. long, dilated below; nervation camptodrome in the entire portions, craspedodrome in the toothed portions, palmately triple nerved from near the base of the leaf, the three nerves equal, one or both of the two lateral usually branching unequally, the lesser branches (subprimaries) passing into the outer lobes; secondary nerves numerous, simple, parallel, making an angle of 40° with the primaries, arching and anastomosing close to the margins or terminating in the teeth; nervilles distinct, straight, percurrent, joining the secondaries, or longer and geniculate, joining the areas between the primaries, sometimes forking or variously crossed to form fine rhombic or polygonal meshes; basal lobes provided with a median nerve or costa.

The numerous fragments of this singular leaf, which were collected in the friable marl bed at the head of Clear Creek, represent all the sizes between the extremes shown in Fig. 5 of Plate XXVII and Fig. 1 of Plate XXVIII, so that scarcely any doubt remains that they represent a single species of varying size and somewhat varying form In the figure last mentioned there seems to have been but one subprimary nerve and but four lobes, and in Fig. 4 of Plate XXVII enough of the base is preserved to make it pretty certain that there were no subprimaries and only three lobes, as may be seen by comparing it with Figs. 3 and 5 of the same plate.

The remarkable feature of these leaves is the unmistakable evidence they present of the existence of basal lobes. Although only one of these (Fig. 5) actually has these lobes, and in this neither lobe is absolutely complete, still this specimen leaves no uncertainty as to their character, and two of the other specimens (Figs. 3, 4) show a conformation of the base of the leaf which clearly indicates that they were also present in these. Recalling the peculiar basal lobes described in one of the species of Platanus (*P. basilobata*, p. 35, Plates XVII, XVIII, XIX) and comparing the general character of these leaves with those we are

now considering, it is impossible to resist the conviction that the two forms have a close natural relationship. The obvious affinity of those leaves to *Platanus nobilis* and of that species to *Aralia notata* seems to link all the forms having this general character into one correlated group. If this be true the problem is reduced to that of discovering what the true generic relationship of this group is. As I showed when discussing that species, the presence of basal lobes argues strongly for the reference of all the forms possessing them to the Platanaceæ, and I fully believe that such a reference will become necessary. But this will not only carry with it all the American forms hitherto referred to Aralia, but, as I also believe, all those referred to Sassafras. If this sweeping change is ever made it may be thought best to distinguish these forms from true Platanus and establish a new genus of that order to be called *Protoplatanus*, or some other name indicative of its ancestral character.

Unquestionably the nearest approach that has yet been made to our form is to be found in *Aralia Saportanea* Lx. (Ann. Rep. U. S. Geol. Surv. Terr., 1874, p. 350, pl. i, figs. 2, 2*a*; Cret. and Tert. Fl., p. 61, pl. viii, figs. 1, 2; pl. ix, figs. 1, 2), and, though a Cretaceous form, but for the basal lobes and short, thick petiole, I might have felt constrained to regard it as specifically identical with that plant. In *Aralia Hercules* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IV, pl. ix, fig. 2), which, however, sometimes has a larger number of lobes (cf. Unger, Chloris Protogæa, pl. xlv, fig. 7), we have another near analogue, and here the petiole is short and much dilated at the base, and in *A. angustiloba* Lx. (Foss. Pl. Aurif. Gravels, pl. v, figs. 4, 5) the lobes are said to be very entire.

ONAGRARIEÆ.

TRAPA L.

Five species of Trapa are described in De Candolle's Prodromus, but Messrs. Bentham and Hooker have reduced them to two or three. They are almost altogether confined to eastern Asia, but one species occurs in temperate Europe. Prior to 1874 the genus was known in a fossil state only by fruits, which have been found in European strata, in the arctic regions in Alaska, and even in British America. Unless we admit Newberry's *Neuroteris angulata* as of this genus, which seems not improbable, leaves were first collected by Dr. F. V. Hayden at Point of Rocks, Wyoming, and later by Mr. William Cleburne in the white sandstone bed east of the station, where I also found them in 1881. Their discovery in 1882, at Burns's Ranch on the Yellowstone, fully justified Lesquereux's determination, previously regarded as doubtful, and I found them the following year not only there but also at Iron Bluff, as already reported in the Sixth Annual Report, p. 544.

Trapa microphylla Lx.

TRAPA MICROPHYLLA Lx., Bulletins U. S. Geol. Surv. Terr., Vol. I, pp. 369, 380; Ann. Rep., 1874, p. 304; Tert. Fl., p. 295, pl. lxi, figs. 16, 17, 17*a*.

?NEUROPTERIS ANGULATA Newberry, Report upon the Colorado River of the West, by Lieut. J. C. Ives, p. 131, pl. iii, fig. 5.

Plate XXVIII, Figs. 2-5.—Burns's Ranch, Wyoming.

The size, shape, and nervation of these leaves are substantially identical with those of Point of Rocks, and until fruit is found for both it will be necessary to regard them as the same species, the significance of which, in tending to homologize the upper and lower districts of the Laramie group, has already been commented upon (see Sixth Annual Report, p. 544). The very perfect specimens collected both by Dr. White and myself at Burns's Ranch show the nature of the plant almost as well as a living specimen could do and demonstrate its complete analogy with the recent forms in its habit of growth. Hitherto only detached leaves had been seen, and the generic reference was made by Prof. Lesquereux, with evident reserve, from the nervation alone. The correctness of this determination is now fully established and goes far to vindicate the oft-disputed claim of vegetable paleontologists that this character alone may in most cases be trusted to show the nature of extinct floras, provided the work be performed by competent investigators.

HAMAMELIDEÆ.

HAMAMELITES Sap.

This genus was created by Saporta for the reception of Watelet's *Corylus elegans*, from Sézanne. To it Prof. Lesquereux has referred five species from the Dakota group, two of which are not figured, and the specimens are not accessible to me. None of them seem to be oblique at the base, which is a leading characteristic not only of the Sézanne leaves but also of the genus Hamamelis. This genus is represented in the living flora by only two species, one of which is North American and the other Asiatic. It is therefore one whose ancestors should, according to modern theories of plant dispersion, be looked for in North American strata.

Hamamelites fothergilloides Sap.

HAMAMELITES FOTHERGILLOIDES Sap., Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. III, p. 47; Fl. Foss. de Sézanne, p. (105) 393, pl. (xi) xxxii, fig. 3. Schimper, Pal. Vég., Vol. III, p. 57; Atlas, pl. xcv, fig. 15.

CORYLUS ELEGANS Wat., Pl. Foss. du Bassin de Paris, p. 146, pl. xxxvii, fig. 5.

Plate XXIX, Fig. 1.—Seven Mile Creek, Montana; bed below the ironstone.

Although there are a few points of distinction between this leaf and those from Sézanne, such as the longer petiole and less prominent teeth,

still there is such a substantial agreement that I prefer not to create a new species for its reception. It resembles *Hamamelis Virginiana* L., the American Witch Hazel, more closely than does the European fossil, and probably belongs to the living genus. In all the leaves I have seen of that species in which the midrib has any curvature, as also in the figures of Watelet and Saporta of the extinct species, this curvature is toward the side of the leaf which shows the least development of parenchyma at the base, thus exaggerating the inequality in the two sides. In our leaf, however, this is reversed, and the side that is lower at the base is narrower above; as a consequence, the secondary nerves are of nearly equal strength on the two sides and about equally branched. Should additional specimens show this to be a constant character it would probably be necessary to assign to it a specific value.

LEGUMINOSÆ.

LEGUMINOSITES Brongn.

Along with a large number of leaves and leaflets which have been provisionally placed under this name a few enigmatic fruits have found their way into the same generic receptacle, although it would have been much more convenient had these been furnished a different name.

Leguminosites arachioides Lx.

LEGUMINOSITES? ARACHIOIDES Lx., Tert. Fl., p. 301, pl. lix, fig. 14.
CARPOLITHES ARACHIOIDES Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1872, p. 403.

Plate XXIX, Fig. 2.—Clear Creek, Montana.

Although these fruits are a little longer and more slender pointed than those from Evanston, there seems no reason to doubt that they represent the same plant. My specimens contribute very little to our knowledge of their nature and are merely introduced to show that the form occurs in the Fort Union Laramie.

SAPINDACEÆ.

ACER L.

Fossil maples are chiefly found in the Miocene, where many species are known both by leaves and fruit. Only three species have been reported from the Laramie group, none of them from those beds which were formerly regarded as constituting that group.

Acer trilobatum tricuspidatum (Al. Br.) Heer.

ACER TRILOBATUM TRICUSPIDATUM (Al. Br.) Heer, Fl. Tert. Helv., Vol. III, p. 49, pl. cxiii, figs. 1, 3–10. Ludwig, Palæontogr., Vol. VIII, p. 129, pl. l, fig. 1; pl. li, figs. 4, 7–9; pl. lii, fig. 2. Engelhardt, Pflanzenreste von Liebotitz und Putschirn (Sitzb. d. Naturw. Ges. Isis, Hefte III u. IV, 1880), p. 7, pl. ii, figs. 1, 4, 5.
ACER TRICUSPIDATUM Al. Br., Neues Jahrb. für Mineralogie, 1845, p. 172.

Plate XXIX, Figs. 3, 4.—Clear Creek, Montana (Fig. 3); collected by Dr. White's party in 1882. Little Missouri River, Dakota (Fig. 4); collected by Hayden and Peale in 1882.

The first specimen (Fig. 3) occurs on a slab containing a profusion of other leaves, including those of *Corylus Americana*, *Populus cuneata*, and *Platanus Raynoldsii*. It closely resembles Heer's fig. 6, on pl. cxiii, above cited, but is larger and has the petiole more slender. The other specimen (Fig. 4) is in the buff marl of the Little Missouri bad land district, and also resembles the figure last cited more than any others I have seen. In both the dentation is less strongly marked than in most maples and they have a certain indefinable appearance that is suggestive of Platanus.

Acer indivisum Web.

ACER INDIVISUM Web., Palæontogr., Vol. II, p. 198, pl. xxii, fig. 2*a*. Heer, Fl. Tert. Helv., Vol. III, p. 60, pl. i, fig. 10; pl. cx, fig. 15; pl. cxvi, fig. 12. Schimper, Pal. Vég., Vol. III, p. 146.

Plate XXIX, Fig. 5.—Carbon Station, Wyoming.

Weber's original specimen was really unlobed, but in one of Heer's (pl. cxvi, fig. 12) there is a lobe on one side and an extra large tooth on the other which the forking of the nerve shows to be virtually a lobe. In another of Heer's figures (pl. i, fig. 10, which he refers to *A. integrilobum* Web. in Vol. I, p. 20, and to *A. indivisum* Web. in Vol. III, p. 60), the side on which the lobe would occur, as shown by the stronger nerve, is wanting; in the only other figure I have seen (op. cit., pl. cx, fig. 15), there are two large lobe-like teeth on one side, but no forking nerve, in which respect it resembles one side of our leaf; but the latter is too broad for the length, and its reference to this species will not probably be justified. It may be further compared with *A. campylopteryx* Ung. (Chlor. Prot., pl. xliv, fig. 1); also, with *Platanus cuneifolia* Göpp. (Foss. Fl. v. Schossnitz, pl. xii, fig. 2).

SAPINDUS L.

This chiefly tropical genus has one living representative in the Southwestern States and is represented by four species in the Laramie group, all but one of which are found in Fort Union strata. The Green River group furnished seven or eight additional species and one (*S. obtusifolius* Lx.) is common to the Fort Union and Green River deposits. The four following forms are from the upper districts.

Sapindus affinis Newberry.

SAPINDUS AFFINIS Newberry, Later Extinct Floras, pp. 31, 51; Illustrations of Cret. and Tert. Plants, pl. xxiv, fig. 1; pl. xxv, fig. 2. Schimper, Pal. Vég., Vol. III, p. 169. Dawson, Geol. 49th Parallel, Brit. N. A. Boundary Commission Report, 1875, p. 330; Cret. and Tert. Fl. Brit. Col. and N. W. Terr. (Trans. Roy. Soc. Can., Sec. IV), p. 32.

Plate XXX, Figs. 1, 2.—Gladstone, Dakota; collected by Hayden and Peale in 1883.

There seems no reason to doubt that these remains represent the same species as that from the mouth of the Yellowstone, although the Gladstone specimens exhibit the nervation much more clearly. In both cases we have quite a collection of the leaves, showing their character under various aspects, and, although Drs. Hayden and Peale collected no specimen showing as large a part of the leaf as does Dr. Newberry's specimen, figured on plate xxiv, above cited, still from the material obtained by them a nearly perfect leaf might be restored.

Sapindus grandifoliolus, n. sp.

Plate XXX, Figs. 3-5; Plate XXXI, Figs. 1, 2.—Seven Mile Creek, Montana; Sapindus bed.

Leaflets large for the genus (3 to 5cm. wide, 7 to 14cm. long), ovate-lanceolate, slender obtuse-pointed, falcate or slightly recurved at the summit, the lower ones stalked on the rachis, the upper sessile; margins entire, but uneven or wavy; nervation pinnate, camptodrome; midrib strong, nearly straight, diminishing perceptibly at each branch; secondaries numerous and approximate (twelve to eighteen on a side), diverging from the midrib at an angle of about 60°, simple or more commonly branching above the middle, curving upward near the margin, and anastomosing with one another or with the branches of the next higher, forming a single series of somewhat broken arches; nervilles very faint, straight, percurrent, joining the secondaries at right angles.

The only form that is fairly comparable to these specimens is that figured on plate xlviii (fig. 5) of Lesquereux's Cretaceous and Tertiary Floras, and referred by him to *S. obtusifolius*. This was collected by Prof. William Denton, in the "Bad Lands of Dakota," and is therefore probably from Fort Union strata. I have not seen that collection, but the figure shows this specimen to have been as large as many of those from Seven Mile Creek and similar to some of these in form and nervation. The leaflet was more unequal-sided, shorter-pointed, and apparently sessile. In these respects it differs from the present specimens, but still may belong to the same species.

This is the form that characterizes the Sapindus bed, or lowest layer of the Seven Mile Creek series, and which was almost the only fossil occurring in it. Although the plant was abundant I did not succeed in finding anything but detached leaflets. In one case (Plate XXXI, Fig. 2), two such leaflets occurred side by side in such a position

that it was evident that they occupied their natural position and that the rachis to which they had been attached had not been preserved. This has been hypothetically restored in the figure, and the attachment of a third leaf alternating with these two is indicated.

This failure to find the rachis or the attachments of the leaflets, coupled with the presence of a petiole (Plate XXX, Fig. 5), and the general equal-sidedness of the impressions gave rise for a long time in my mind to doubts as to whether they really represented a Sapindus. The form is quite similar to that of *Juglans acuminata* Heer (Fl. Tert. Helv., Vol. III, pl. cxxviii), but the finer nervation, so far as known, is wholly different. The disposition of the secondary and tertiary nerves is not unlike that seen in Nyssa (cf. Lesquereux, Tert. Fl., pl. xxxv, fig. 5, also living species). There is, however, no good reason to doubt the correctness of the reference to Sapindus.

Sapindus alatus, n. sp.

Plate XXXI, Figs. 3, 4.—Seven Mile Creek, Montana; Sapindus bed.

Leaflets oblong-ovate, long recurved-pointed, contracted at the base into a winged stalk; nervation pinnate, camptodrome; midrib somewhat curved; secondary nerves eight to ten on each side, the lowest ones opposite; basilar pair light, simple, proceeding from the summit of the winged stalk; second pair strongest, branched above and somewhat zigzag, curving upward and following the margins; remaining pairs more or less irregular, curving and anastomosing at some distance from the margin, and forming several rows of irregular polygonal meshes; nervilles simple and percurrent, joining the secondaries, or geniculate, branched, and very irregular.

In the absence of the upper portion of the smaller of these impressions (Fig. 4) it is impossible to say whether they represent the same species. The winged stalk and general nervation are similar, but the ultimate disposition of the nerve bundles is very different. If we consider only the larger and more perfect specimen (Fig. 3), we find that, with the exception of its long recurved point, it quite closely resembles some of the forms of *S. obtusifolius* (cf. Lesquereux, Tert. Fl., pl. xlix, fig. 10; Cret. and Tert. Fl., pl. xlviii, fig. 6). The great irregularity of the secondary and tertiary nervation is suggestive of abnormality, which sometimes does occur in the course of the nerves as well as in the contour of leaves.

Sapindus angustifolius Lx.

SAPINDUS ANGUSTIFOLIUS Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1873, p. 415; Tert. Fl., p. 265, pl. xlix, figs. 2-7; Cret. and Tert. Fl., p. 181, pl. xxxvii, figs. 1-8; pl. xxxix, fig. 12.

Plate XXXI, Figs. 5-7.—Seven Mile Creek, Montana; Sapindus bed; the last (Fig. 7) collected by Dr. White's party in 1882.

None of these specimens is absolutely complete. The first (Fig. 5) wants the summit, which may have been acute-pointed or somewhat

obtuse. The rounded obtuse or truncate summit of the second specimen (Fig. 6) seems to be deformed and the curvature of the midrib immediately below it seems to indicate that the leaf originally had a somewhat elongated, recurved point, like that represented in Lesquereux's Tertiary Flora (pl. xlix, fig. 5). The third and smallest specimen (Fig. 7) exactly imitates the leaflets of his fig. 3, loc. cit., as also of his figs. 1 and 5 on plate xxxvii of the Cretaceous and Tertiary Floras. Numerous unfigured specimens in the collection of the National Museum further confirm these analogies.

If this reference is correct, we have two species of Sapindus common to the Green River and Fort Union deposits. But the genus is a troublesome one, owing to the difficulty in obtaining specimens with the leaflets attached and to the apparent great variation among the leaflets of the same species. Our North American species (*S. marginatus* Willd.) does not seem to show any such variation, the leaflets being of nearly uniform size and shape; but if this were assumed for the fossil forms the number of species would be very great. As all of my specimens come from the same layer in the Seven Mile Creek series, I have been tempted to regard them all as belonging to one polymorphous species, and the dozen or more species described from American strata may have to be reduced to three or four.

AMPELIDEÆ.

VITIS L.

This large genus, now made to embrace Cissus and Ampelopsis, contains over two hundred species, most of which are tropical and subtropical, but in America about fifteen species occur north of Mexico. Out of some thirty or forty fossil species that have been described five are found in the Laramie strata, but none of these comes from the Fort Union deposits. The only Eocene species are three from Sézanne, which shows the similarity of that flora to that of the Laramie. Four forms occur in my collections which seem sufficiently distinct to be classed as different species, and I have not been able to refer any of these to species already described. Two of them were collected at Carbon Station, and the remaining two at Burns's Ranch, on the Yellowstone.

Vitis Bruneri, n. sp.

Plate XXXII, Figs. 1, 2.—Carbon Station, Wyoming.

Leaves large, as broad as long (8.5cm.), three-lobed near the summit, obtuse-dentate to near the base; nervation strongly palmate, craspedodrome; primary nerves five to seven, arising together from the base of the leaf; median nerve largest, central or more or less eccentric, zigzag or somewhat curved, having four or five lateral branches on each

side; inner pair of lateral primaries next in volume, proceeding at an angle of 30° from the midrib to the lateral lobes, giving off subdichotomously three or four strong branches from the under side and some times feeble ones from the upper side; outer pair forming an angle of 60° with the midrib and yielding secondary branches from the under side for nearly its whole length, which terminate in the lowest teeth of the margin; basilar pair when present very light, following the margin closely and uniting with the first branches of the secondary nerves; nervilles geniculate, percurrent, or forked, traversing the primary and secondary areas.

Unable to refer these fine and highly characteristic specimens to any of the species hitherto described, I have allowed them to bear the name of my esteemed companion who assisted in their collection.

There is a great similarity in nearly all the leaves collected at Carbon Station, and when all are fully studied and illustrated I hope to find data for completing the description of this form. At present it seems as if several additional species of Vitis were represented. These specimens lack the petiole and differ somewhat from one another, but not enough to warrant their separation. If we attend only to the disposition of the nerves we shall perhaps find nearer analogues in Hedera than in Vitis (cf. *H. primordialis* (Sap.) Heer, Fl. Foss. Arct., Vol. VI, Abth. II, pl. xxiv, fig. 6*a*). In all the species of Vitis that I have examined the lowest pair of primary nerves is horizontal or even pass downward, but the leaves are heart shaped, while these are nearly horizontal or slightly wedge shaped at the base. With this exception the form and nervation approach somewhat closely to *Vitis crenata* Heer (Fl. Foss. Arct., Vol. II, Pt. II, Fl. Foss. Alask., pl. viii, fig. 6), next to which may be compared *Cissus lobato-crenata* Lx. (Tert. Fl., pl. xli, figs. 1–3).

Vitis Carbonensis, n. sp.

Plate XXXII, Fig. 3.—Carbon Station, Wyoming.

Leaf long-petioled, unequal-sided, three lobed, bluntly crenate-dentate, except near the slightly wedge-shaped base, 7.5cm. wide, 8.5cm. long; petiole 6cm. long, very thick, flabellately divided at the summit into five strong primary nerves; median nerve considerably thickest, curved near the base 30° out of line with the petiole, and passing far to one side of the middle of the leaf, bearing seven or eight branches on each side, which pass into the teeth; lateral primaries unequal on the two sides, the inner pair going to the lobes, somewhat branched from the under side; outer nerve on the larger side of the leaf bearing five branches, which pass into the lower teeth; a very thin basilar nerve present on the larger side; secondary nervation simple or forked; nervilles generally indistinguishable, bent, broken, or forking.

This leaf has many characters in common with those last described, one of which is somewhat one-sided and has the middle nerve bent

near the base, and, with the comparison of more material, intermediate forms may be discovered. I have compared it with *Cissus Radobojensis* Ett. (Unger, Sylloge, I, pl. ix, figs. 9, 10), which, while having much the same general form, has only three primary nerves and is more deeply lobed. It also closely resembles *Acer vitifolium* Heer (Fl. Tert. Helv., Vol. III, pl. cxvii, fig. 14), which might well represent a Vitis.

Vitis Xantholithensis, n. sp.

Plate XXXII, Figs. 4, 5.—Burns's Ranch, Montana.

Leaves small (3cm. wide, 3 to 4cm. long), ovate or elliptical in outline, bluntly and irregularly somewhat doubly-toothed all around; petiole long, slender, flexuous; nervation palmate, craspedodrome; primary nerves five, rising nearly together from the summit of the petiole; median nerve a little the largest, slightly curved, branching above; inner pair of lateral nerves strong, erect (20°), branched below from the outside, forked above; lower pair light and basilar or stronger and much branched from the under side; secondary nerves once or twice forking near their extremities, the branches sometimes joining to form angular arches, the ultimate ramifications entering the subordinate teeth; nervilles indistinct, much broken, penetrating the areas, forking at wide angles, and disappearing in the parenchyma.

This species resembles *Cissus tricuspidata* Lx. (Tert. Fl., pl. xli, figs. 6, 7), but is smaller and differently toothed. One of the specimens (Fig. 4) is almost identical in form and nervation with one of Heer's figures of *Grewia crenata* (Fl. Tert. Helv., pl. cx, fig. 6), while the other has many points in common with *Celtis trachytica* Ung. (Foss. Fl. v. Szantó, Denkschr. Wien. Acad., Vol. XXX, pl. ii, fig. 7), especially as figured by Saporta (Monde des Plantes, p. 309, fig. 3), who, however, has shown the teeth much less sharp. In many respects these leaves recall the characteristics of Hedera, but upon the whole I still incline to regard them as representing a Vitis. I am not sure that my *Populus craspedodroma* (*supra*, p. 21, Pl. VIII, Fig. 3) does not belong here.

Vitis cuspidata, n. sp.

Plate XXXII, Figs. 6–8.—Burns's Ranch, Montana (Figs. 6, 7). Seven Mile Creek, Montana; bed below the ironstone (Fig. 8).

Leaves short-petioled, coriaceous, small (1.5 to 2.5cm. wide, 3 to 4 cm. long), unequal-sided, pointed at both ends, deeply and obtusely or sharply cuspidate-toothed, except the entire wedge-shaped base; nervation craspedodrome, imperfectly palmate; midrib curved or zigzag, branching; lower lateral nerves strong, erect, dichotomously branched, passing into the longest teeth or cusps; secondary nerves branching or forking, terminating in the teeth; nervilles distinct, percurrent, crossed at right angles by veinlets that traverse the areas longitudinally, often appearing like faint, intercalary secondaries.

The three specimens embraced under this specific head all differ slightly in certain characters. In the first (Fig. 6) the teeth are sharper, some of them incurved, and the nervation is distinctly palmate, while in the third (Fig. 8) the teeth are shorter and more blunt and the lowest lateral nerves are light on one side and rather pinnately disposed. This last specimen is from a different locality, a fact which I overlooked in preparing my "Synopsis," and which in so far argues for their separation.

It is easy enough to find figures roughly corresponding with these small impressions, but it increases the difficulties greatly to find that these belong to widely different genera and families. I was from the first struck with their resemblance to the leaves of certain species of Cratægus, e. g., *C. coccinea* L., *C. monogyna* Jacq., *C. triloba* Pers., *C. tomentosa* L., but here the teeth are always too sharp and incised. In *Myrica diversifolia* Lx. (Cret. and Tert. Fl., pl. xxv, figs. 6–15) we have forms that reproduce some of the characters of our leaves, and in *Rhus incisa* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. VIII, pl. xi, fig. 4) and *Myrsine? acanthoda* Sap. (Pl. Foss. des Arkoses de Brives, pl. v, fig. 5) we have others. The dichotomous nervation and blunt teeth of two of the specimens (Figs. 7, 8) are partially duplicated in *Viburnum spinulosum* Heer (Fl. Foss. Arct., Vol. V, Pt. III, Prim. Foss. Fl. Sachal., pl. xi, fig. 9) and less perfectly in *Grewiopsis tremulæfolia* Sap. (Fl. Foss. de Sézanne, pl. xxxiii, fig. 8). The small specimen wanting the base (Fig. 7) imitates to a remarkable degree, both in form and nervation, the fruits of Carpinus (cf. *C. cuspidata* Sap., Études, Ann. Sci. Nat., Bot., 4e Sér., Vol. XIX, pl. v, fig. 7C, and *C. Neilreichi* Kov., Unger, Europ. Waldbäume, fig. 10). But it is after all perhaps under Vitis, particularly among the forms with compound leaves, that the nearest analogues of our forms are to be sought. *Cissus quinquefolia* Pohl., from Brazil (Ettingshausen, Blattsk. d. Dicotyl., pl. xliii, fig. 5) comes quite close, and among fossils *C. tricuspidata* Lx. (Tert. Fl., pl. xli, figs. 4–7) furnishes in some of its forms (cf. loc. cit., fig. 6) the nearest analogy I have found.

RHAMNEÆ.

BERCHEMIA Neck.

This genus embraces about ten species, chiefly confined to the Old World, largely to southeastern Asia, where so many arctic and American fossil plants have their living representatives.

One species, however, still persists in North America and very closely resembles our fossil form. Three species have been reported in the fossil state, the most abundant of which occurs in American strata, and I have it from both sections of the Laramie group.

Berchemia multinervis (Al. Br.) Heer.

BERCHEMIA MULTINERVIS (Al. Br.) Heer, Fl. Tert. Helv., Vol. III, p. 77, pl. cxxiii, figs. 9–18. Capellini, Lig. Val di Magra (Mem. Reale Accad. Sci. di Torino, Ser. II, Vol. XIX), p. 385, pl. iii, fig. 6. Sismonda, Pal. Tert. du Piémont (Mem. Reale Accad. Sci. di Torino, Ser. II, Vol. XXII), p. 452, pl. xxix, fig. 8. Saporta, Études (Ann. Sci. Nat., Bot., 5e Sér., Vol. VIII), p. 107, pl. xii, figs. 2, 3. Ettingshausen, Foss. Fl. v. Bilin, III (Denkschr. Wien. Acad., Vol. XXIX), p. 41, pl. xlix, figs. 15–17; Foss. Fl. v. Sagor, II (op. cit., Vol. XXXVII), p. 196, pl. xvi, figs. 7–10. Schimper, Pal. Vég., Vol. III, p. 225. Geyler, Foss. Pfl. a. d. Obertert. Ablag. Sicilien's (Palæontographica, Vol. XXIII), p. 327, pl. ii, fig. 6. Lesquereux, Tert. Fl., p. 277, pl. lii, figs. 9, 10. Velenowsky, Fl. v. Vrsovic, p. 42, pl. iv, figs. 26, 27. Pilar, Fl. Foss. Susedana, p. 107, pl. xiv, fig. 12.

RHAMNUS MULTINERVIS Al. Br., in Buckl. Geol., Vol. I, p. 513.

BERCHEMIA PARVIFOLIA Lx., Am. Journ. Sci., 2d ser., Vol. XLV, p. 207; Ann. Reps. U. S. Geol. Surv. Terr., 1867–'69, p. 196; 1870, p. 382; 1871, Suppl., p. 15.

Plate XXXIII, Figs. 1, 2.—Bull Mountains, Montana: collected by Hayden and Peale in 1883 (Fig. 1). Golden, Colorado (Fig. 2).

Mr. Lesquereux (Tert. Fl., p. 281) seems to think that the presence of tertiary nerves proceeding from the lower secondaries could not occur in Berchemia, and he therefore referred all such to Rhamnus; but I find such nerves very faintly shown in some leaves of *B. volubilis* DC., and I do not regard this character as of sufficient weight to be treated as generic. My Golden specimen is larger than most of those referred to this species. It is also more narrowed at the base, and approaches Ludwig's figure of *Cornus orbifera* Heer (Palæontogr., Vol. VIII, pl. lviii, fig. 12), which may well have been a Berchemia. This specimen is from the tufa beds.

The Bull Mountain specimen is in red baked clay and shows the nervation very clearly. The nervilles are stronger and smoother than in other cases and pass across the areas more nearly at right angles to the secondary nerves, in so far resembling Ficus.

ZIZYPHUS Juss.

A widely distributed tropical and subtropical genus containing in the present flora about fifty species; quite abundant in a fossil state, ranging from the upper Cretaceous (Patoot, Greenland) to the Pliocene. It has been hitherto represented by eight Eocene, one Green River, and five Laramie species, none of the last being from Fort Union strata.

Z. serrulatus, n. sp.

Plate XXXIII, Figs. 3, 4.—Burns's Ranch, Montana; one specimen (Fig. 4) collected by Dr. White's party in 1882.

Leaves short petioled, ovate, 2.8cm. wide, 3.5cm. long, rather finely and sharply serrate or sometimes crenate to near the base; nervation palmate, acrodrome, craspedo-camptodrome; petiole dividing at its dilated summit into three nearly equal primary nerves; median nerve

slightly curved, nearly simple; lateral primary nerves very erect (20° to 30°), curving regularly upward and inward to the point of the leaf, forming an elliptical area which the midrib divides equally, branched from the outside, the branches curving upward at some distance from the margin and joining one another in a series of undulations or arches, from which short veinlets pass directly into the teeth; nervilles geniculate or broken, crossed in the middle by finer fibers and the tertiary areas filled by a dense network of quadrate or polygonal meshes.

In both of the specimens the summit is wanting. The substance of the leaf is clearly preserved, leaving a black coating of discernible thickness upon the light-brownish or ash-colored rock. In one (Fig. 4) the area between the lateral primaries appears to have the epidermis removed, exposing the detailed nervation very perfectly. There is considerable difference in the dentation of the two specimens, as also in the shape of the base, but this can scarcely be regarded as specific.

In *Z. ovoideus* Mass. (Fl. Foss. del Senigal., pl. xxxix, fig. 10) we have precisely the same form as in our specimens, except that the teeth are entirely wanting. In that figure the central part of the leaf shows the fine network of the ultimate fibers very much as in our specimen above referred to (Fig. 4). It is, however, to *Z. Meekii* Lx. (Tert. Fl., pl. li, figs. 10–14) that our form is probably most nearly allied, and, considering the variations already admitted to occur in that species, it may not be possible to keep them permanently distinct.

Zizyphus Meekii Lx.

ZIZYPHUS MEEKII Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1872, pp. 388, 389; Tert. Fl., p. 275, pl. li, figs. 10–14. Schimper, Pal. Vég., Vol. III, p. 611.

Plate XXXIII, Figs. 5, 6. Carbon Station, Wyo. (Fig. 5). Bozeman Coal Mines, Montana (Fig. 6); collected by Hayden and Peale in 1883.

None of the specimens figured by Lesquereux conform precisely to these impressions, but there are others in the collection from Carbon made by Lesquereux and Meek, but not figured, which much more closely resemble the one collected there by myself (Fig. 5). The Bozeman specimen is longer in proportion to its width than any thus far referred to this species, and in this respect it agrees better with most living species. The nervation and dentation are those of *Z. Meekii*, and I scarcely feel warranted in separating it on account of the shape alone.

Zizyphus cinnamomoides Lx.

ZIZYPHUS CINNAMOMOIDES Lx., Tert. Fl., p. 277, pl. lii, figs. 7, 8; Cret. and Tert. Fl. p. 189.

CEANOTHUS CINNAMOMOIDES Lx., Ann. Rep. U. S. Geol. Surv. Terr., 1871, p. 289.

Plate XXXIII, Fig. 7.—Seven Mile Creek, Montana; white marl bed.

Very similar to Lesquereux's fig. 7 (specimen not in National Museum collection), less distinctly toothed than his fig. 8 (No. 431, Nat. Mus.

II.); not unlike Unger's *Ceanothus Bilinicus* (Chlor. Prot., pl. xlix,).

A number of small obovate forms of very enigmatical character occurred in the white marl bed of the Seven Mile Creek series, of which is a case showing the extreme elongation. I was at first disposed regard them all as depauperate forms of *Populus cuneata*, so abundant the same bed, but their further study has compelled me to distribute them to the three genera Zizyphus, Paliurus, and Grewia. They will be further considered under the two last named genera.

PALIURUS Juss.

Only two species of Paliurus are known in the living flora of the be, one of which is confined to southern China, the other to southern rope and western Asia. About a dozen fossil species have been described, chiefly from leaves alone, of which two are from the Laramie oup and one from Green River strata, at Florissant, Colo. Without winged fruit no one will claim that it is possible to distinguish this nus from Zizyphus, or, perhaps, from Ceanothus. The three following forms, therefore, are liable to be transferred to either of those nera should they ever be discovered in connection with their fruits.

Paliurus Colombi Heer.

PALIURUS COLOMBI Heer, Fl. Foss Arct., Vol. I, p. 122, pl. xvii, fig. 2*d*; pl. xix, figs. 2–4; Vol. II, Pt. III (Mioc. Fl. Spitzb.), p. 67, pl. xiv, fig. 11; Pt. IV (Foss. Fl. N. Greenland), p. 482, pl. l, figs. 18, 19; Vol. IV, Pt. I (Foss. Fl. Spitzb.), p. 91, pl. xxxi, fig. 8; Vol. V, Pt. II (Foss. Fl. Sibir.), p. 35, pl. ix, fig. 2*a*, 2*b*; Pt. III (Prim. Fl. Foss. Sachal.), p. 52, pl. xiii, figs. 1–3. Lesquereux, Tert. Fl., p. 273, pl. l, figs. 13–17. Schimper, Pal. Vég., Vol. III, p. 217.

Plate XXXIII, Figs. 8–10.—Burns's Ranch, Montana (Figs. 8, 9, the latter collected by Dr. White's party in 1882). Carbon Station, Wyoming (Fig. 10).

The Burns's Ranch specimens are identical in form with those previously collected at Carbon, while my specimen from Carbon is longer in proportion to its width and entire margined; it is, however, obscure, and the portions of the margin where a tooth or small lobe sometimes occurs is wanting. It may be compared with Heer's Spitzbergen figure, and especially to his Sachalin, figures 2 and 3. As this specimen occurs on the same slab as the next one to be described, I think it quite possible that it represents the same plant, although the differences, as will be seen, are very considerable.

Paliurus pulcherrimus, n. sp.

Plate XXXIII, Fig. 11.—Carbon Station, Wyoming.

Leaves small (2.7cm. wide, 4cm. long), petioled, ovate-lanceolate, pointed, rounded at the base, undulate margined to near the base, the undulations small, numerous, and regular; petiole about a centimeter

long; nervation palmate, camptodrome; midrib strong, straight, central, having about ten thin alternate branches above the middle; lateral primary nerves rather small, rising from the base of the blade, opposite, symmetrical, leaving the midrib at an angle of 40°, curving upward and at length inward (acrodrome), giving off eight or nine short, nearly straight, parallel, secondary nerves at equal distances apart, which fork and either anastomose in a series of arches near the margins or appear to lose themselves in the parenchyma; secondaries from the midrib more distant and less regular, forking, the two lowest joined to the primaries; nervilles very faint, dichotomous or broken.

By the aid of counterparts all but the immediate point of this leaf is found to be preserved and there can be no doubt as to its characters as above described. It occurs upon a slab of calcareous sandstone of a very dark color, which contains impressions of other leaves and confused vegetable remains, among which are branching stems of coaly aspect, one of which passes along the base of the petiole of this leaf in such a manner as to render it next to certain that it grew from it, although it is difficult to make out the actual attachment. Among the fragments of leaves scattered about on the stone are several that seem to be identical with this, and it is here, as above remarked, that one of the specimens last mentioned (Fig. 10) occurs. More minute study of all these impressions may necessitate the union of all the forms of similar nervation and justify their attachment to the stems with which they are associated.

Paliurus Pealei, n. sp.

Plate XXXIII, Figs. 12-14.—Little Missouri River, Dakota; collected by Dr. A. C. Peale in 1883.

Leaves small (1 to 2.5cm. wide, 1 to 4cm. long), petioled, ovate, pointed, somewhat oblique or gibbous, finely and regularly crenate-toothed to near the narrowed or nearly horizontal base; petiole 6 to 12 mm. long, slightly curved, rather thick; nervation subpalmate, craspedo-camptodrome, one or two basilar nerves on each side, usually rising from near the summit of the petiole, either simple or the stronger ones giving off short tertiary nerves to the lower teeth; lateral subprimaries rising from a short distance above the base of the blade, very erect, curving, and acrodrome, having numerous outer branches which fork and unite near the margin, from which short branches run into the teeth; nervilles bent or geniculate, traversing the areas between the primaries.

These pretty little leaf-prints occur in buff shales of the Bad Lands of the Little Missouri and, with the exception of their immediate summits, are in a very good state of preservation. The extremes in size represented by Figs. 12 and 14 are joined by the intermediate form shown in Fig. 13, and all doubts as to their specific identity are thus removed.

Their form is closely imitated by many leaves (cf. *Celtis McCoshii* Lx., Cret. and Tert. Fl., pl. xxxviii, fig. 8; *Celastrinites elegans* Lx., op. cit., pl. xxxi, figs. 9, 10; *Celtis Japeti* Ung., Iconogr., pl. xliii, fig. 26, Europ. Waldb., fig. 28; *Myrsine Radobojana* Ung., Sylloge, III, pl. vii, fig. 1), but the nervation does not correspond precisely in any I have examined. In *Zizyphus Ungeri* Heer, the type of which is more elongated, there occur forms which approach them quite closely (cf. Unger, Foss. Fl. v. Sotzka, pl. lv, figs. 3, 5, 7, 8; Ettingshausen, Foss. Fl. v. Hæring, pl. xxv, figs. 18, 25, 29, 37), but these all want the basilar nerves and have the acrodrome lateral primaries rising from nearer the base and passing up much closer to the margin. In *Paliurus tenuifolius* Heer, especially the specimen from Aix figured by Saporta (Études, Ann. Sci. Nat., Bot., 4e Sér., Vol. XVII, pl. xii, fig. 5), we find perhaps the nearest approach to our plant, with suprabasilar nerves and short thick petiole, but no nerves are shown below the principal primaries and the dentation is comparatively feeble.

CELASTRINEÆ.

CELASTRUS L.

Of the eighteen species known to occur in the present flora of the globe only one (*C. scandens* L.) is a native of North America. The greater part of the species, however, inhabit the mountains of eastern Asia, where they seem to have taken refuge on the retreat of the glacial invasion. A few lingered in the southern hemisphere and became acclimated there.

In the fossil flora this genus plays a very important rôle. Schimper in 1874 was able to enumerate fifty-four species, and the number has since been largely increased. Up to that time the genus had been confined to the Tertiary deposits of Europe. Subsequent arctic explorations have revealed the existence of a number of species at the north, in the Miocene strata of Greenland, Spitzbergen, Alaska, and Sachalin. One species is found in the upper Cretaceous of Patoot, but most of the celastraceous fossils occurring in the Cretaceous, as well as those from the Paleocene of Sézanne and Gelinden, are assigned to the extinct genera Celastrinites and Celastrophyllum. Two species of Celastrinites are described by Lesquereux from the Laramie group and three species of Celastrus from the Green River group.

Realizing the importance to paleontology of this group of plants, Baron von Ettingshausen, as early as 1856, published a memoir on the nervation of the Celastrineæ (Denkschr. Wien. Acad., Vol. XIII, p. 43), illustrated physiotypically by ten plates; but the species of Celastrus figured in that work belong chiefly to the Cape of Good Hope and now fall under the genus Gymnosporia, and it is not among these that we have to look for the analogues of our American fossil forms. The specimens

here referred to this genus, and in fact all that I place in this order come from Fort Union strata. I am unable to assign them to any known species and am forced to regard them as new, at least for the present. One type of nervation, with minor modifications, characterizes them all and this seems to me best exemplified in the American species of Celastrus, especially in the more ample leaves of that species. The most striking and uniform feature of this type of nervation is the peculiar manner in which the secondary nerves arch near their extremities and supply short subsidiary nerves to the teeth of the margin.

Celastrus ferrugineus, n. sp.

Plate XXXIV, Figs. 1-4.—Burns's Ranch, Montana (Fig. 1). Iron Bluff, Montana collected by Dr. White's party in 1882 (Figs. 2-4).

Leaves thin and membranaceous, ovate or oblong, petioled, slightly heart-shaped, pointed, regularly and sharply simply serrate to near the often oblique base, 4 to 6cm. wide, 6 to 8cm. long; petiole short (5 to 9mm. long), thick, usually somewhat curved, dilated downward; nervation pinnate, craspedo-camptodrome; midrib large below, somewhat dilated at the nodes, rapidly diminishing upward, the reduction very perceptible at each node, sometimes slightly zigzag, more or less curved; secondary nerves well developed, approximate, parallel, seven to ten on each side, often unequally distant on the two sides, issuing from the midrib at a broad angle (40° to 60°), curving upward in crossing the lamina, each nerve branching more or less dichotomously toward its extremity, the branches only entering the teeth, the lowest ones being previously joined by the main portion of the nerve below in such a manner as to form a series of angled arches along and at some distance from the border; nervilles distinct, percurrent or forking, more or less flexed, somewhat horizontal.

These four specimens differ somewhat from one another and may possibly represent two or more species, but they agree in so many particulars that no difficulty is experienced in giving them a common character. The Burns's Ranch specimen (Fig. 1) seems certainly to be the same as the largest one from Iron Bluff (Fig. 2). From this to the other Iron Bluff specimen of the same ovate shape (Fig. 3) the transition is not violent, although the oblique base and somewhat knotted midrib are quite peculiar features. It is in these last named characters that this specimen agrees with the remaining one (Fig. 4), giving these two a very similar general aspect, which seems to make one ignore the considerable difference of form. All the specimens are thus bound together by characters such that, although when we compare the extremes (as Fig. 1 with Fig. 4) we see little to prove their relationship, still, when we consider them all as a group, we find it very difficult to say where the line of separation should be drawn. If any separation is to be made it would seem that all must be disunited and four distinct forms recognized; for

even in the case of the first two (Figs. 1 and 2) the continuation of the teeth to the very base in one of them (Fig. 2) is a character not elsewhere seen in the group.

These forms all differ from *C. scandens* L. by their heart shaped base and sharper teeth. In both these respects, however, they are more nearly matched by *C. scandentifolius* Web. (Palæontogr., Vol. II, pl. xxii, fig. 10*a*) from the lignites of the Lower Rhine, but in the more angular arches their nervation deviates from both these species.

While I believe that all the characters of these leaves taken together point more strongly to Celastrus, or at least to the Celastrineæ, as their proper affinity than to any other group of plants, it must nevertheless be admitted that other genera and families combine many of them and that their final assignment must be postponed until further evidence is received. I was at first disposed, as Baron Von Ettingshausen seems to be, to refer them to the Rosaceæ, and I found in the living genus Amelanchier many things with which to compare them (see leaves of *A. Canadensis* T. & G. and of *A. Botryapium* DC., Ett. Blattsk. der Dicotyl., pl. lxxxix, fig. 11). I do not, however, consider this view at all strengthened by a comparison with *A. similis* Newberry (Illustrations, pl. xxv, fig. 6), which is as likely to be a celastraceous leaf (cf. *Celastrus scandentifolius* Web., loc. cit.; also in Unger, Sylloge, II, pl. ii, fig. 22).

The nervation of Fraxinus is also somewhat like what we see here, but the leaflets of that genus are usually narrower. In *F. abbreviata* Lx. (Cret. and Tert. Fl., pl. xxviii, figs. 5, 6), however, we have them exhibiting nearly the same proportions as in our leaves. I have already mentioned (*supra*, p. 33) the analogy which these forms present with Juglans, and some of our present specimens may profitably be compared with some species of that genus (see Heer, Foss. Fl. Arct., Vol. II, Pt. II, Alaska, pl. ix, fig. 5).

Celastrus Taurinensis, n. sp.

Plate XXXIV, Figs. 5, 6.—Bull Mountains, Montana (Fig. 5). Burns's Ranch, Montana; collected by Dr. White's party in 1882 (Fig. 6).

Leaves rather thin, large (7cm. wide, 12cm. long), oblong, slightly heart shaped, pointed, sharply and coarsely serrate to near the base; nervation pinnate, craspedodrome; midrib rather thin, slightly curved, thickened at the nodes; secondary nerves nine to eleven on each side, alternate or subopposite, curving upward, forking or branching, occasionally arching and supplying short veinlets to the teeth, lowest pair thin, basilar, and mostly simple; nervilles more or less curved, percurrent or more commonly forked, joining the secondaries at right angles.

It is with some hesitation that I have finally decided to unite these two forms in one species and refer them to Celastrus. They come from widely different sections and occur in very dissimilar rock, the Bull

Mountain specimen being in soft white clay. In the Burns's Ranch leaf the secondaries are more erect and straighter and the teeth, which are larger, are slightly incurved. In form and size they are comparable to *Populus balsamoides* Göpp. (cf. Foss. Fl. v. Schossnitz, pl. xv, fig. 3; Gaudin, Gisements, pl. iii, fig. 1), but the sharp teeth and craspedodrome nervation seem to make such a reference out of the question. Possessing the peculiar nervation of the Celastrineæ, I seem compelled to assign them to that family, but reasons will be given later (*infra*, p. 95) for considering it possible that they may belong to Pterospermites or Grewiopsis. The specimen, Fig. 15, may be compared with *Elæodendron Sagorianum* Ett. (Foss. Fl. v. Sagor, II, Denkschr. Wien. Acad., Vol. XXXVII, Abth. I, pl. xvi, fig. 25).

Celastrus alnifolius, n. sp.

Plate XXXV, Figs. 1, 2.—Burns's Ranch, Montana; one of the specimens (Fig. 2) collected by Dr. White's party in 1882.

Leaves broad, oblong-ovate, 6cm. wide, 8cm. long, irregularly serrate to near the oblique base; petiole 2.5cm. long, slightly inflated below, curved to one side; nervation pinnate, craspedodrome; midrib strong, nearly straight; secondary nerves about nine on a side, the lower nearly opposite, the upper alternate, issuing at an angle of 40° to 45°, slightly curving upward and forking or branching, usually anastomosing to form angled arches which give off short nerves to the teeth of the margins; nervilles distinct, usually forking, joined by very fine oblique veinlets, which form a network of polygonal meshes.

The shape and general aspect of these two leaves are very similar, but a difference is visible in the nervation, which at first strongly inclined me to separate them. In one of the specimens (Fig. 2) the secondary nerves are less curved upwards and branch dichotomously, the two divisions often running directly into the teeth. This, however, is not always the case, and some of the branches show a disposition to form arches. Upon the whole I can scarcely doubt, coming as they both do from the same bed, that they represent the same species; but the nearly opposite lower nerves, the general shape, dentation, &c., certainly remind one strongly of Alnus. In *Alnus cardiophylla* Sap. (Fl. Foss. de Sézanne, pl. xxxvi, fig. 8) the characters here presented are visible along with still greater anomalies; compare also *A. serrata* Newberry (Illustrations, pl. xvi, fig. 11). Nevertheless, it seems impossible to detach these forms from the general series now under consideration.

Celastrus pterospermoides, n. sp.

Plate XXXV, Figs. 3–6.—Burns's Ranch, Montana (Figs. 3, 4, 6). Iron Bluff, Montana (Fig. 5).

Leaves thin, rather large (5 to 6cm. wide, 10 to 15cm. long), oblong, slightly heart shaped, horizontal, or oblique at the base, coarsely and

prominently serrate, petioled; nervation pinnate, craspedodrome; midrib very thick below, rapidly diminishing; secondary nerves inequidistant, the lower ones crowded together, horizontal or directed a little downward, middle and upper ones somewhat curved upward, branching, arching, and joining, the arches supplying short branches to the teeth; nervilles mostly percurrent, somewhat flexuous, the areolæ between them occupied by a fine network of quadrate or polygonal meshes.

The special characteristic of all these leaves by which they seem separable from the others of this series is the manner in which the lateral nerves near the base are huddled together on the thick midrib, proceeding out horizontally or somewhat radially, reminding one of the nervation of Credneria, Protophyllum, and Pterospermites. Otherwise they seem to have the general nervation of the group and may be compared with *Celastrus borealis* Heer (Fl. Foss. Arct., Vol. II, Pt. II, Alaska, pl. x, fig. 4).

Celastrus ovatus, n. sp.

Plate XXXVI, Fig. 1.—Iron Bluff, Montana.

Leaf ovate, pointed, narrowed and rounded at the base, very symmetrical, 6cm. wide, 11cm. long, sharply and somewhat unequally serrate; nervation pinnate, craspedodrome; midrib thick below, rapidly thinning above, straight; secondary nerves twelve to thirteen on a side, nearly equidistant and parallel, alternate, slightly curving upward, forking or branching and arching, the ultimate ramifications entering the teeth; nervilles indistinguishable.

This nearly perfect and very symmetrical leaf from Iron Bluff was considered sufficiently distinct to be separated from those previously described, but such separation is chiefly based on the ovate shape. It seems to occupy an intermediate position, having the base similar to *C. alnifolius*. The petiole is wanting, but from the midrib it is safe to judge that it was thinner than in the last species. While it seems to belong to this group, its affinities with the Betulaceæ are strong and it may be compared with *Betula Sezannensis* Sap. (Fl. Foss. de Sézanne, pl. xxxvi, figs. 9, 10).

Celastrus grewiopsis, n. sp.

Plate XXXVI, Fig. 2.—Burns's Ranch, Montana.

Leaf lanceolate, obliquely heart shaped, strongly serrate to the base; nervation pinnate, craspedo-camptodrome; midrib very large, straight; secondary nerves issuing at a wide angle and curving upward, following the margin or curving inward to join the next higher, giving off from the elongated arches thus formed a number of short tertiary nerves which enter the teeth; nervilles percurrent, somewhat flexuous, occasionally forked.

This specimen, of which the upper portion is wanting, presents a considerable modification of the general type, both in its narrower elongated outline and in the extreme upward curvature of the lateral nerves. Its strongly toothed, heart shaped base recalls forms of Grewia. But for the strongly craspedodrome tertiary nerves the nervation would be that of *Juglans nigella* (cf. Fl. Foss. Arct., Vol. II, Pt. II, Alaska, pl. ix, fig. 2*a*), and the leaf figured by Sieber under the name of *Rhus Meriani* Heer (Zur Kenntniss d. Nordböhm. Braunkohlenflora, Sitzb. Wien. Acad., Vol. LXXXII, Abth. I, pl. v, fig. 39) imitates it very closely. The specific name should be written with a small initial letter to denote its resemblance to Grewia and not to Grewiopsis.

Celastrus curvinervis, n. sp.

Plate XXXVI, Figs. 3, 4.—Burns's Ranch, Montana; the larger specimen (Fig. 4) collected by Dr. White's party in 1882.

Leaves elliptical or lanceolate, recurved-pointed, 5 to 8cm. wide, 12 to 15cm. long, regularly serrate; nervation pinnate, craspedo-camptodrome; midrib curved; secondary nerves much curved upward and at length inward, forming elongated arches, from which short tertiaries proceed to the teeth; nervilles very oblique, usually forked, the areolæ occupied by quadrate meshes.

The great difference in the width of these leaves is perhaps sufficient to warrant their separation, but the nervation seems to be precisely the same. The midrib is too thin to justify their union with the form last described, to which they are related by the much curving secondary nerves. The base is wanting in both. The nervation, including the form of the finer meshes, is very similar to that of *Euonymus Proserpinæ* Ett. (Foss. Fl. v. Bilin, III, Denkschr. Wien. Acad., Vol. XXIX, pl. xlviii, figs. 6, 7); it may also be compared with that of *Celastrus Dianæ* Heer (Fl. Foss. Arct., Vol. VI, Abth. I, Pt. II, Nachtr. z. Foss. Fl. Grönlands, pl. iii, fig. 6*a*) and of *C. fraxinifolius* Lx. (Cret. and Tert. Fl., pl. xxxiii, figs. 2–4).

EUONYMUS L.

The genus Euonymus embraces about forty species, the greater part of which inhabit the mountains of India, China, and Japan. Three species are indigenous in North America. About fifteen fossil species are known, only one of which is from American strata.

Euonymus Xantholithensis, n. sp.

Plate XXXVII, Figs. 1, 2.—Burns's Ranch, Montana.

Leaves oblong or obovate, 4.5cm. wide, 10cm. long, petioled, rather finely and sharply serrate to near the base; nervation pinnate, craspedo-camptodrome; midrib thick below, rapidly diminishing above, nearly straight; secondary nerves about twelve on a side, alternate or subopposite, ir-

regular as to distance and angle, curving upward near the margin and following it, uniting at their extremities with the branches of the next higher, furnishing short tertiary nerves to the teeth of the margin; nervilles oblique, chiefly percurrent.

This form finds its nearest representatives in the living species *E. atropurpureus* Jacq., common in the United States, and in the East Indian species, *E. pendulus* Wall. (Ettingshausen, Nervation d. Celastrineen, Denkschr. Wien. Acad., Vol. XIII, pl. x, fig. 7). It wants the long point and sharp, coarse teeth of the Green River form (*E. flexifolius* Lx., Cret. and Tert. Fl., pl. xxxviii, fig. 13). It approaches somewhat closely to some of the figures of *Rhamnus Gaudini* Heer (cf. Fl. Tert. Helv., pl. cxxv, fig. 1), and may also be compared with *Cupania Neptuni* Ung. (Sylloge, I, pl. xv, figs. 7, 8). That it is generically distinct from the preceding forms it would be rash to insist.

ELÆODENDRON Jacq.

Of the dozen or more fossil species of this now chiefly tropical Old World genus that have been thus far described only one has been found in American strata (*E. Helveticum* Heer, Lesquereux, Mioc. Fl. of Alaska, Proc. Nat. Mus., Vol. V, 1882, p. 449, pl. ix, fig. 4). The form and nervation of the leaves which I have grouped under this name are too near those that have been so referred to be separated generically from them without additional data for so doing. The genus to which they are next most closely related by these characters is Ilex, and to this they may eventually be relegated. But they seem to form part of the same general group which has just been considered, and it seems best to regard them as members of the same family. They are generally smaller and more elongate and are distinguished as to their nervation by the curving of the secondary nerves farther from the margin and the frequent formation of a double row of arches or of a series of large polygonal areolæ.

Elæodendron serrulatum, n. sp.

Plate XXXVII, Figs. 3–5.—Burns's Ranch, Montana (Figs. 3, 4). Seven Mile Creek, Montana (Fig. 5).

Leaves thin, short petioled, elliptical or ovate, 4 to 4.5cm. wide, 7 to 8cm. long, pointed at the summit, narrowed or slightly heart shaped at the base, finely and sharply irregularly serrate to very near the base; nervation pinnate, craspedo-camptodrome, brochiodrome; midrib straight or somewhat uneven, strong; secondary nerves rather light, distant, branching early, and turning abruptly upward and at length inward, uniting with the lowest branch of the next higher, forming angled arches, or often continuing upward and joining with other branches of the next higher in such a manner as to produce a series of

secondary undulations inclosing rows of D-shaped areolæ; nervilles usually percurrent, flexuous, curved, or geniculate.

The nervation of these leaves approaches more nearly that of *E. Hæringianum* Heer (Fl. Tert. Helv., pl. cxxii, fig. 6) than that of any other plant that I have been able to compare it with. It nevertheless resembles that of certain Rosaceæ more closely than in any of the previous cases (cf. Fig. 3 with *Amelanchier typica* Lx., Cret. and Tert. Fl., pl. xl, fig. 11; also, with *A. Canadensis* T. & G., living, and with *Pyrus serrulata* Göpp., in Palæontogr., Vol. VIII, pl. lxiii, fig. 6). In *Euonymus Szantoinus* Ung. (Foss. Fl. v. Szantó, Denkschr. Wien. Acad., Vol. XXX, pl. iv, fig. 5) we have again this type of nervation, which is an exaggeration of the normal celastroid type. All the species of Elæodendron physiotypically figured in Ettingshausen's memoir above cited (Denkschr. Wien. Acad., Vol. XIII, pl. i, ii) exhibit it in greater or less degrees.

Elæodendron polymorphum, n. sp.

Plate XXXVIII, Figs. 1-7.—Burns's Ranch, Montana; the first four specimens (Figs. 6-9) collected by Dr. White's party in 1882.

Leaves rather thick and coriaceous, elliptical-lanceolate, narrowed or somewhat truncated at the base, pointed at the summit, very variable in size (2 to 3.5cm. wide, 5 to 8cm. long), short petioled, finely and sharply serrate to near the base; petioles thick, dilated below, slightly curved; nervation craspedo-camptodrome, brochiodrome; midrib slightly curved; secondary nerves rather distant, irregular, curving upward and forming one or two rows of angled arches inclosing loose polygonal areolæ, the numerous short ultimate branchlets entering the teeth; nervilles distinct, flexed near their centers, forking and variously joining within the areas to form rather coarse polygonal meshes.

The seven specimens here figured, all from the same bed, differ greatly in size and considerably in form and nervation, but after prolonged study I have not found constant characters upon which I can consistently separate them. The smaller ones show only one row of arches; one of these (Fig. 9) has a much longer petiole than the rest, and the secondary nerves are more approximate and regular; another (Fig. 12) is ovate-lanceolate and somewhat heart shaped at the base. The ultimate nervation is also different in different specimens, the nervilles being simply percurrent in some.

The first specimen (Fig. 6) may be compared with *E. Gaudini* Heer (Fl. Tert. Helv., pl. cxxii, fig. 3). In *E. degener* Ett. (Foss. Fl. v. Bilin, III, Denkschr. Wien. Acad., Vol. XXIX, pl. xlix, figs. 9, 10) we have forms allied to other of our specimens (Figs. 9, 10, 11). *Celastrinites Hartogianus* Sap. (Fl. Foss. de Sézanne, pl. xxxvi, fig. 15) may also be compared with Fig. 6, and *Celastrus Persei* Heer (Fl. Tert. Helv., pl. cxxii, fig. 1), with Fig. 7. *Euonymus Radobojanus* Ett. (Foss. Fl. v. Bilin,

III, pl. xlviii, fig. 8) furnishes as near an approach as we find to the small specimen, Fig. 9, while in *Celastrus fraxinifolius* Lx. (Cret. and Tert. Fl., pl. xl, fig. 10) we have a form similar to Fig. 11. We thus find forms of fossil plants that have been referred to the Celastrineæ with which to compare nearly all the specimens here grouped together. None of these, however, are very similar to the smallest of these specimens (Fig. 12), and for analogues to this we are obliged to look in other genera. Perhaps the nearest approach to this specimen is furnished by Heer's *Fraxinus prædicta*, particularly the Portuguese specimens (cf. Fl. Foss. du Portugal, pl. xxii, figs. 5–8). Next to this come forms of Salix (cf. *S. varians* Heer, Fl. Foss. Arct., Vol. II, Pt. II, Alaska, pl. ii, fig. 8; *S. primæva* Sap., Fl. Foss. de Sézanne, pl. xxviii, figs. 5–8). Notwithstanding these close analogies I am disposed to regard this form as representing an extreme modification of the general type to which all these specimens belong. In fact it is not difficult to find analogues of all the rest in genera that have not been referred to the Celastrineæ. Compare, for example, *Ilex ambigua* Ung. (Fl. Foss. v. Kumi, Denkschr. Wien. Acad., Vol. XXVII, pl. xiii, fig. 19) and *Aralia hederacea* Sap. (Fl. Foss. de Sézanne, pl. xxx, fig. 5) with our Fig. 6, *Rhamnus Warthana* Heer (Braunk. Fl. Zsily-Thal., pl. v, figs. 2, 3) and *Cunonia Bilinica* Ett. (Foss. Fl. v. Bilin, III, pl. lv, fig. 21) with Fig. 9.

TILIACEÆ.

GREWIA L.

A large genus (sixty species) of mostly tropical Old World plants, found in considerable abundance in the European Miocene, also in that of the arctic regions. One species, *G. auriculata* Lx., is reported from the John Day River region of Oregon, also Miocene.

Grewia crenata (Ung.) Heer.

GREWIA CRENATA (Ung.) Heer, Fl. Tert. Helv., Vol. III, p. 42, pl. cix, figs. 12–21; pl. cx, figs. 1–11; Fl. Foss. Arct., Vol. IV, Pt. I (Foss. Fl. Spitzb.), p. 84, pl. xix, figs. 12–14. Ettingshausen, Fl. Tert. v. Bilin, III (Denkschr. Wien. Acad., Vol. XXIX), p. 15, pl. xlii, fig. 7. Schimper, Pal. Vég., Vol. III, p. 118. Zwanziger, Mioc. Fl. v. Liescha, p. 68, pl. xxvi, fig. 1. Saporta, Monde des Plantes, p. 325, fig. 98, No. 1. Staub, Aquitan. Floraja, p. 31, pl. iii, figs. 2, 3.

DOMBEYOPSIS CRENATA Ung., Gen. et Spec., p. 448.

Plate XXXIX, Fig. 1.—Bull Mountains, Montana; collected by Hayden and Peale in 1883.

This impression, which occurs in the soft white clay of Bull Mountains and wants both petiole and summit, has precisely the form of many of the figures of *G. crenata*. The parts of the leaf that are present are very perfectly preserved, and upon close inspection it appears that the

margins, instead of being crenate, are minutely sharply serrate, teeth being usually provided with short nervelets from the arches the secondary system. Whether this is sufficient to remove it from t species or even from the genus I will not now attempt to decide. Sho the latter be necessary the Rhamneæ would seem to be the order i which it must find its way, where it will find analogues in Paliu Ceanothus, Zizyphus, &c. In this connection it may be advantage to compare it with *Zizyphus tiliæfolius* (Ung.) Heer (Chlor. Prot., xlix, figs. 3, 4) and with *Paliurus Favonii* Ung. (op. cit., pl. l, figs. 7,

? Grewia celastroides, n. sp.

Plate XXXIX, Fig. 2.—Iron Bluff, Montana.

Leaf large (8cm. wide), ovate (?), slightly heart shaped, coarsely sharply serrate to near the base, petioled; nervation pinnate, crasp odrome; midrib as thick as the petiole, curved near the base; ondary nerves numerous, approximate, parallel, comparatively li gently curved upward, lower ones nearly horizontal, opposite, branch the rest alternate, forking, the ultimate ramifications entering the te nervilles distinct, flexuous, often forked, traversing the areas at ne right angles to the nerves.

Since submitting my paper for the Sixth Annual Report of the Uni States Geological Survey, in which this species and the next recei their present designations after such a study as I was then able to g them, I have been led by grave doubts to reinvestigate this entire gro and while I cannot claim to have settled the question of the generic r tionship of these forms I have at least found reason to doubt still m strongly their affinity with the genus Grewia. It is true that in *tiliacea* Ung. (Sylloge, III, pl. xiii, figs. 12, 13) the nervation is pinn and analogous to that of these specimens and that some living spec as *G. Asiatica* L., *G. occidentalis* L., &c., have a somewhat similar ne tion, but the normal disposition of the nerves of the genus is palmat subpalmate and somewhat acrodrome. While many are crenate even dentate they are rarely so prominently and sharply toothed a these forms. They are generally more or less camptodrome, even w serrate, and the secondary nerves do not fork.

In Grewiopsis, as founded by Saporta on Sézanne specimens, the considerable deviation from the type of Grewia in the direction more pinnate nervation, but the lowest nerves are usually more asce ing and none of the secondaries are dichotomous. As extended Lesquereux to embrace Laramie forms this deviation is carried furt In *G. Saportana* Lx. (Tert. Fl., pl. l, figs. 10–12), though the marg are nearly entire, the secondary nerves are pinnate and somewhat dic omous. In the Dakota group forms of the same author (Cret. Fl., pl figs. 2, 4; pl. xxiv, fig. 3) these characters appear still more distinc

and if these references are correct they seem to furnish a clew to the proper relationship of the forms under consideration.

Our present specimen, as will be perceived, is from the same bed that furnished the forms referred to Celastrus. If its upper portion had been preserved it might have exhibited the peculiar celastroid nervation seen in these forms, but this peculiar nervation is also seen in some forms of Grewiopsis (cf. *G. tremulæfolia*, Fl. Foss. de Sézanne, pl. xxxiii, fig. 8; *G. Saportana* Lx., Tert. Fl., pl. l, fig. 11; *G. Cleburni* Lx., op. cit., pl. lxii, fig. 12), and the question may yet arise whether these forms can be so widely separated, as well as the question to what family of plants they really belong.

? Grewia Pealei, n. sp.

Plate XXXIX, Figs. 3-5.—Bull Mountains, Montana; collected by Dr. A. C. Peale in 1883.

Leaves petioled, ovate, heart shaped, 6 to 7cm. wide, 7 to 10cm. long, strongly toothed to near the base; petiole 2 to 3cm. long, thickened below, straight; nervation pinnate, craspedodrome; midrib thick at the lower end, visibly diminishing at each slightly dilated node, straight; secondary nerves comparatively light, close together, especially near the base of the leaf, chiefly alternate, the lowest ones rising at an acute angle, immediately curving outward and somewhat downward nearly parallel to the auriculate base, giving off short tertiary nerves which enter the lower teeth, successively higher ones becoming horizontal and somewhat erect, curving upwards and branching more or less dichotomously, yielding tertiaries which sometimes further branch or fork, the ultimate ramifications reaching the margin without arching or anastomosing; nervilles faint, percurrent or forked, straight or somewhat bent, traversing the areas at right angles to the nerves.

These specimens occur in the soft white clay of Bull Mountains, and, though none of them shows the summit of the leaf, the base and central portion are preserved in the most perfect state. All that was said respecting the last species applies to the present one and need not be repeated. The specimen (Pl. XXXIV, Fig. 6) which is described on page 79 as *Celastrus Taurinensis* is from the same bed and occurs in immediate association with these. I was at first inclined to regard them all as belonging to the same variable plant, but a close comparison shows a great difference in the nervation, not, however, without numerous points of resemblance. It may still be necessary to unite them.

I have found scarcely anything with which to compare these forms. Perhaps they approach more closely to *Grewiopsis sidæfolia* Sap. (Fl. Foss. de Sézanne, pl. xxxii, fig. 10) than to any other form thus far made known, and it is to that genus rather than to Grewia that I now incline to refer them, along with the one last described

Grewia obovata Heer.

GREWIA OBOVATA Heer, Fl. Foss. Arct., Vol. IV, Pt. I (Foss. Fl. Spitzb.), p. 86, pl. xix, figs. 15, 15*b*.

Plate XXXIX, Figs. 6, 7.—Seven Mile Creek, Montana; white marl bed.

One of the greatest difficulties in the study of such forms as these is the great number of plants which it is possible to find having wholly different botanical relationships which still imitate them very closely, even to the details of nervation. Thus we may compare these leaves with *Persoonia laurina* Heer[1] (Fl. Tert. Helv., pl. xcvii, figs. 25–28), with *Paliurus zizyphoides* Lx. (Tert. Fl., pl. li, figs. 1–6), with *Elæodendron psilocarpum* (Ettingshausen, Blattsk. d. Dicotyl., pl. lxiii, fig. 3), with forms of Coprosma (op. cit., pl. xxiv, xxv), of Celastrus (op. cit., pl. lxii, lxiii), of Salix (Heer, Fl. Foss. Arct., Vol. II, Pt. III, Spitzb., pl. xvi, figs. 62–66; Ett., Physiotypia Pl. Austr., Vol. I, pl. xxv, figs. 4–6), of Cinnamomum, Bumelia, Aralia, Proteoides, Pterocelastrus, Melastomites, Hypericum, &c. Great confusion and doubt necessarily result, and one is compelled to fall back largely upon circumstantial evidence. Thus, as already remarked when speaking of another of these forms (*supra*, p. 75), I was at first disposed to look upon them as immature and anomalous leaves of *Populus cuneata*, and this I still regard as possible, but upon the whole not probable. They may all belong to Zizyphus or Paliurus, or they may possibly be proteaceous. This last, however, is improbable on general principles. The nervation, so far as it can be made out, seems to be that of the species to which I have referred them, and one of the specimens (Fig. 6) is an almost exact reproduction on a little smaller scale of Heer's plant as restored by him (loc. cit., fig. 15*b*). Doubtful as their affinities are, the impressions are in themselves quite perfect.

GREWIOPSIS Sap.

Forms of this extinct type were first described by Marquis Saporta from the Paleocene of Sézanne, and Prof. Lesquereux's discovery of several Laramie species supposed to belong to the same genus is a further proof of the correctness of his remark that there is a close resemblance between the Laramie and these lowest Eocene beds of France and Belgium. The following forms, if correctly referred to this type, will go far to confirm this view, as well as to show the essential unity of the Fort Union and lower Laramie system.

As already remarked my two species, *Grewia celastroides* and *Grewia Pealei*, above described, should also probably be referred rather to Grewiopsis.

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[1] *P. laurina* Pers. (*P. ferruginea* Smith) is an Australian species having almost precisely the same form (cf. Ettingshausen, Blattsk. d. Dicotyl., pl. v, figs. 8, 9). Heer makes no mention of this in the text (op. cit., p. 95), but names *P. daphnoides* as the nearest analogue of his plant. This seems to be a remarkable coincidence, if it is nothing more.

Grewiopsis platanifolia, n. sp.

Plate XL, Fig. 1.—Seven Mile Creek, Montana; Sparganium bed.

Leaf ovate, pointed, broadly cuneate at base, petioled, 9cm. wide, 10cm. long, sinuate-dentate to below the widest part; nervation palmate, craspedodrome; midrib strong, slightly curved; lateral primaries rather light, rising from the base of the leaf at an angle of 35°, proceeding straight to the margin above the middle of the leaf, or curving inward near the margin and uniting with a branch of the next nerve above, each throwing out a large branch from the lower side a short distance above the origin (which also proceeds nearly straight to the margin and bears four or five tertiaries), branching again two or three times near the extremities or from the arches; secondary nerves from the midrib five on each side, the lower ones nearly as large as the lateral primaries, opposite and parallel to them and to one another, simple or with one or two branches from the lower side and one light branch from the upper side, which curves and joins the outer one from the next higher, forming a sort of arch from the summit of which a short nervelet passes into the adjacent tooth of the margin; nervilles indistinct, simple and percurrent, or forked, straight, and somewhat oblique, or more or less bent or curved.

This specimen was picked up on the surface, where it had been somewhat weather worn, so as to render certain parts of the nervation difficult to make out, which doubtless accounts for the apparent difference in the nervation of the two sides. It is not possible to say with certainty whether it is the main trunk of the secondaries that curves upward near the margin to join a branch from the lower side of the next higher or whether this proceeds directly to the margin and gives off a smaller nerve from the upper side. The latter is what seems to take place on the left side of the figure above, but it is so unusual and the other so common that I can but think that if the specimen were better preserved the latter would be found to be the real state of the case. So, too, on the other side, the absence of branches or arches must be attributed to their indistinctness or complete obliteration on the rock. This celastroid nervation is seen in several of Saporta's figures of Grewiopsis, particularly in *G. tremulæfolia* (Fl. Foss. de Sézanne, pl. xxxiii, fig. 8), and to better advantage in the American species (cf. *G. Saportana* Lx., Tert. Fl., pl. l, fig. 11, and *G. Cleburni* Lx., op. cit., pl. lxii, fig. 12). But for this character there might be good reason for referring this plant to Platanus, although its resemblance to *P. Guillelmæ*, the principal nonlobate species, is not close in other respects. It is perhaps nearer to Lesquereux's figure of *Quercus platania* Heer (Tert. Fl., pl. xxi, fig. 1).

Grewiopsis viburnifolia, n. sp.

Plate XL, Fig. 2.—Burns's Ranch, Montana.

Leaf small (4.2cm. wide, 5.7cm. long), elliptical or somewhat rhombic, obtuse-pointed, cuneate, at base, sharply toothed to below the widest

part; petiole nearly 2cm. long, curved below; nervation palmate, craspedodrome; midrib strong, straight; lateral primary nerves comparatively light, subopposite, rising from above the base of the blade at an angle of less than 30° and proceeding straight to near the margin, where they abruptly curve upward and terminate in the teeth, each provided with a very light basilar nerve and five or six parallel, equidistant tertiary nerves which curve and sometimes fork in passing to the margins; secondary nerves from the midrib five or six on each side, alternate, parallel to the lateral primaries and to one another, curving slightly upward and inward at their extremities, rarely forking close to the margin; nervilles distinct, mostly percurrent and perpendicular to the nerves joined, those near the margins often flexed in the middle and sending short veinlets to the sinuses or to subordinate teeth.

The character last described gives the nervation a slightly celastroid appearance. In the species last described the curved veins that skirt the margins and were regarded as branches of the secondaries are so faint that it may well be doubted whether they may not be more correctly regarded as nervilles such as we have here. In the present case all doubts are removed.

I had long supposed that this specimen, which, with the help of a counterpart, we are able to present in an almost perfect state, represented a form of Heer's *Viburnum Whymperi* (Fl. Foss. Arct., Vol. II, Pt. IV, Greenland, pl. xlvi, fig. 1*b*), which Prof. Lesquereux thinks may occur in Laramie strata (cf. Tert. Fl., p. 225, pl. xxxviii, fig. 7; pl. lxi, fig. 23), and which is closely related to *V. vitifolium* Sap. & Mar. (Saporta, Monde des Plantes, p. 216, fig. 36); but close inspection shows that it can scarcely belong to that genus. It is not impossible that it is a diminutive form of *Platanus Guillelmæ* Göpp. (cf. Tert. Fl. v. Schossnitz, pl. xi, figs. 1, 2); but this theory, too, I have been compelled to abandon in favor of regarding it as a Grewiopsis. Its nearest analogue would then be *G. Cleburni* Lx., already so often cited, which differs only slightly from *G. tremulæfolia* Sap., also frequently referred to in discussing the present group. For other analogues, see *Platanus Newberriana* Lx. (Cret. Fl., pl. ix, fig. 3), which may well be a Grewiopsis; *Populus attenuata* Al. Br. (Ludwig in Palæontographica, Vol. VIII, pl. lxvii, fig. 8); and *Alnus trinervia* Wat. (Pl. Foss. de Paris, pl. xxxiv, fig. 7).

Grewiopsis populifolia, n. sp.

Plate XL, Figs. 3-5.—Burns's Ranch, Montana; the first (Fig. 3) collected by Dr. White's party in 1882.

Leaves rather large (6 to 10cm. wide, 7 to 12cm. long), round elliptical, sinuate-dentate or blunt toothed to near the cuneate, more or less decurrent base, petioled; nervation palmate, craspedodrome; midrib straight or slightly curved, central, rather light, sometimes dichotomous

at the summit; lateral primary nerves alternate, subtended by thin basilar ones, rising from above the base of the blade at an angle of 35° to 40° from the midrib, gently curving upward in passing to the margin far above the middle, giving off about six developed branches from the outer (lower) side which also curve slightly upward, often branch or fork and go to the margins; secondary nerves from the midrib about five on each side, chiefly alternate, parallel to the lateral primaries and to one another, branching, sometimes dichotomously, towards their extremities; nervilles rather faint, chiefly straight, percurrent and perpendicular to the nerves they join, those near the margins flexed in the middle and sending short veinlets to subordinate teeth.

These three impressions, all from the same bed, are perhaps sufficiently similar to be grouped together as one species, and it is possible that the form last described, which resembles the last of the present group (Fig. 5), may belong with it. They have a strong general resemblance to the larger Sézanne forms (*G. credneriæformis* Sap., *G. anisomera* Sap., and *G. tiliacea* Sap., Fl. Foss. de Séz., pl. xxxiii, xxxiv), but no very close analogy with the American forms of Grewiopsis, unless it be *G. tenuifolia* Lx. (Tert. Fl., pl. xl., fig. 14).

The presence in each case of basilar nerves, as well as the rounded teeth, recalled the character of Populus so forcibly that I was once of the opinion that the second and third forms (Figs. 4, 5) at least belonged to that genus. The last of these (Fig. 5) imitates states of *P. alba* L. of the living flora (cf. Saporta, Vég. Foss. de Meximieux, pl. xxiv, fig. δ) and the other (Fig. 4) may be compared to *P. nervosa elongata* Newberry (Illustr., pl. xiii, fig. 1), *P. Gemellarii* Mass. (Fl. Foss. del Senigal., pl. ix, fig. 13), or *P. sclerophylla* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IV, pl. vi, fig. 13A). This leaf also simulates certain fossils belonging to other genera, as, e. g., *Cissus parrotiæfolia* Lx. (Tert. Fl., pl. xl., fig. 15), *Protoficus crenulata* Sap. (Fl. Foss. de Séz., pl. xxvii, fig. 5), *Sterculia variabilis* Sap. (loc. cit., pl. xxxiii, fig. 6), *Pterospermites inæquifolius* Sap. (loc. cit., figs. 3–5), *P. spectabilis* Heer (Fl. Foss. Arct., Vol. VI, Abth. I, Pt. II, Nachtr. Foss. Fl. Grönld., pl. vi, fig. 10), and *Alnus trinervia* Wat. (Fl. Foss. de Paris, pl. xxxiv, fig. 7). The largest specimen (Fig. 3), however, is more on the type of Platanus and was at first regarded as such. Excepting that it is not at all lobed it has somewhat the character of *P. Raynoldsii* Newberry, as shown in his Fort Union specimen (Illustr., pl. xviii). It may also be compared to *P. Heerii* Lx. (Cret. and Tert. Fl., pl. iii, fig. 1), as may also the smaller leaf (Fig. 5). This last also very forcibly recalls certain arctic forms of *P. affinis* Lx. (Fl. Foss. Arct., Vol. VII, pl. lvii, figs. 2, 4, pl. lix, fig. 7), a species which Lesquereux now relegates to Cissites (Cret. and Tert. Fl., p. 67).

Notwithstanding these affinities this puzzling group may for the present be left where it is.

Grewiopsis ficifolia, n. sp.

Plate XLI, Figs. 1, 2.—Black Buttes Station, Wyoming.

Leaves thin, ovate or elliptical, 4cm. wide, 7 to 8cm. long, rounded at the summit, cuneate at base, denticulate or nearly entire, except at the apex; nervation pinnate, craspedo-camptodrome; midrib conspicuously zigzag or nearly straight; secondary nerves about six on each side, very irregular, erect, branched or forked, curving upward near the margin, and uniting with branches of the next higher, forming somewhat angular undulations from which nervelets either proceed to the margin or in turn curve before reaching it and form lesser arches, the outer arches sending veinlets to the margins; nervilles very prominent, irregular in direction, much bent or broken and variously combined and traversed by short branches, forming rather large, quadrate, rectangular, or trapeziform meshes, those near the margin heavier, geniculate in the middle, where they are joined to the border by a short veinlet.

The characters of the nervation above described, as well as the form of the leaf, are so similar to those of *G. Saportana* Lx. (Tert. Fl., p. 257, pl. l, figs. 10–12) that, when we remember that those specimens also came from Black Buttes Station, Wyoming, it seems very probable that they all belong to one and the same species of plant. The chief difference is in the ultimate nervation, which is much more prominent in our specimens, though this may have been due to the accident of preservation. This has many things in common with Ficus and may be compared to that of *F. asarifolia* Ett. (Fl. Tert. v. Bilin, I, Denkschr. Wien. Acad., Vol. XXVI, pl. xxv, figs. 2, 3) and *F. tiliæfolia* Heer (loc. cit., fig. 4). It may also be seen in *Ficus Carica* L. and other living species. But this same peculiarity also occurs in the Laurineæ, the nervation of which closely resembles that of Ficus. The specimen from the same bed (Pl. XXV, Fig. 1) referred to *Daphnogene elegans* Wat. (*supra*, p. 51) is similar in some respects to the specimen Fig. 2, and the other specimen (Fig. 1), aside from its denticulate apex, very closely agrees with *Laurus Clementinæ* Pilar (Fl. Foss. Susedana, pl. vii, fig. 15). It is also interesting to compare the nervation of these leaves with the Cretaceous forms of Hedera (*H. platanoidea* Lx., Cret. and Tert. Fl., pl. iii, fig. 5, 6; *H. Schimperi* Lx., op. cit., pl. iv, fig. 7).

Grewiopsis paliurifolia, n. sp.

Plate XLI, Fig. 3.—Black Buttes Station, Wyoming.

Leaf of firm consistency, small (3.5cm. wide, 4.5cm. long), obovate, blunt-pointed, cuneate at base, coarsely and irregularly sinuate-dentate to below the middle, petioled; nervation pinnate, craspedodrome; midrib somewhat zigzag, central; secondary nerves few (four or five on a side), very erect (30°), irregular and curving upward and passing into the teeth, the lowest bearing four or five outer tertiaries, the rest simple

or once branched, joined near their extremities by flexed cross-nerves (nervilles?), which supply from the angle at the middle short branchlets to intermediate teeth of the margin; nervilles faint, irregular and variable, sometimes forming quadrate or trapeziform meshes.

The size and to some extent the shape of this leaf are intermediate between *G. Cleburni* Lx. (Tert. Fl., pl. lxii, fig. 12) and *G. orbiculata* Sap. (Fl. Foss. de Séz., pl. xxxii, figs. 11, 12), but it is more narrowed at the base, so as to appear slightly obovate. The nervation is characteristic of the group.

Of all other outlying genera it approaches most closely to *Paliurus Colombi* Heer (cf. Fl. Foss. Arct., Vol. I, pl. xvii, fig. 2*d*), but it may also be compared to *Parrotia pristina* Heer (op. cit., Vol. IV, Pt. I, Spitzb., pl. xxi, fig. 5). Some of the smaller and doubtful forms of *Viburnum marginatum* Lx. (cf. Tert. Fl., pl. xxxviii, figs. 2, 3) resemble it, as does *V. dichotomum* Lx. (loc. cit., fig. 6), and, coming as they do from the same locality, these may really represent the same plant. Two of these specimens (loc. cit., figs. 3 and 6) show the characteristic nervation of Grewiopsis and may not belong to Viburnum. There is another specimen of *V. dichotomum* in the collection (No. 966) which is narrowed at the base and agrees still better with our plant. This specimen is remarkable for having a fragment of a bone of the famous dinosaur, *Agathaumas sylvestris* Cope, preserved on the reverse of the same stone, all these specimens having been collected in this saurian bed.

STERCULIACEÆ.

PTEROSPERMITES Heer.

The genus Pterospermum embraces fourteen species, which are all confined to tropical Asia. Baron von Ettingshausen referred to that genus certain leaf impressions found near Vienna, but Schimper prefers to refer these, as well as all the leaves and fruit resembling those of Pterospermum, to the allied extinct genus Pterospermites, founded by Heer on the fruits found in Switzerland. The greater part of the species known by their foliar organs have been found at the North and are described in Heer's Flora Fossilis Arctica. They are for the most part distinguished by the presence of light horizontal or somewhat descending basilar nerves, sometimes by a slightly peltate character, recalling the forms of Credneria, Protophyllum, and Aspidiophyllum. In *P. inæquifolius* Sap., however, and the other continental forms these characters are not manifest. In those which I would place here they are more or less apparent.

Pterospermites cordatus, n. sp.

Plate XLI, Fig. 4.—Seven Mile Creek, Montana; bed below the ironstone.

Leaf coriaceous, heart shaped, 8cm. wide, entire at the base; nervation pinnate, camptodrome; midrib large below, rapidly diminishing;

secondary nerves alternate, distant, two pairs rising together from the immediate base of the midrib, the lowest ones light and descending, following the margins of the lobes, the other pair still somewhat descending and following the curvature of the margins at some distance, curving inward at their extremities and uniting with branches of the next higher, giving off several tertiary nerves which arch and anastomose with one another, the rest stronger, ascending, branched, forming arches along the margin; nervilles simple, percurrent, straight or curved, traversing the very broad areas, joining the secondaries together and to the midrib, forming a sort of concentric network.

Only the lower portion of one side and a triangular segment 7cm. long of the central part of this leaf are preserved, but these parts are so distinctive that they furnish reliable data for restoring the leaf. The thin basilar nerves are not wholly unlike those of the arctic forms. The entire and deeply cordate base somewhat resembles that of *P. cordifolius* Heer, from the Greenland Cretaceous (Fl. Foss. Arct., Vol. VI, Abth. II, Kreidefl. v. Grönlnd., pl. xxvii, figs. 2, 3); it is also much like *P. spectabilis* Heer (loc. cit., Abth. I, Pt. III, Mioc. Fl. N. Can., pl. ii, fig. 1).

From a superficial point of view this form might be regarded as more nearly related to Apeibopsis, and may be compared to *A. discolor* Lx. (Tert. Fl., pl. xlvi, figs. 4, 6), also to *A. Doloesi* Heer (Fl. Tert. Helv., pl. cix, figs. 9–11). There is, however, some probability that the upper portion of the leaf was sinuate or even dentate margined.

Pterospermites Whitei, n. sp.

Plate XLI, Figs. 5, 6.—Burns's Ranch, Montana; collected by Dr. C. A. White in 1882.

Leaves thick and coriaceous, large (7 to 8cm. wide, 12cm. long), oblong, heart shaped, regularly sinuate or rounded dentate; petiole 3 to 4cm. long, straight, very thick, broadening downward, and grooved or fluted, the auricles of the leaf overlapping its summit from the under side; nervation pinnate, craspedo-camptodrome; midrib strong, rapidly diminishing, slightly inflated at the nodes, more or less curved or sinuous above; secondary nerves five or six on a side, lowest pair opposite, very thin and short, strictly basilar, the rest alternate, distant, horizontal or ascending, curving upward and forming arches, or more frequently giving off tertiary nerves from near their extremities, which pass directly into the rounded teeth of the margins; nervilles very prominent, passing into tertiary nerves, simple and percurrent or forked and variously intersected, those from the midrib curved, forming an open concentric web.

The two specimens here designated are the only ones that have as yet been discovered in the collection. The preliminary study which I gave them in the spring of 1883 sufficed to keep their characters fresh in my mind when a few months later I visited the spot where Dr. White

had obtained them and searched diligently for additional representatives, but without success. I was at first disposed to regard them as belonging to Apeibopsis, and I compared them carefully with Heer's *A. Deloesi*, above referred to. In general form they agree with his figures quite well, but the nervation is here decidedly craspedodrome above and the margins are nowhere entire. The first specimen of the group next to be considered (Plate XLII, Fig. 1) was obtained at the same time and place, and, though much smaller, seems to belong to the same type of leaves, so much so that I was quite disposed to attach it rather to the present group. But this specimen shows several sharp teeth along its upper left border, and these probably continued increasingly to the summit. From the great similarity in the two forms I think it not improbable that either of these specimens, had the summits been preserved, might have shown a tendency there to the formation of a more decided dentation. On the reverse of the same stone that contains one of these specimens (Fig. 6) occurs the specimen that is described on page 82 as *Celastrus curvinervis* (Pl. XXXVI, Fig. 4), the direction of the nerves of which, as well as its size and shape, inclined me to hope that it represented the summit of another leaf of this species. The very different dentation, however, and also the markedly celastroid nervation decided me to separate them, but not without some misgivings, and I regard the question as still debatable whether a considerable number of the forms above described, both as celastraceous and as tiliaceous, may not be genetically related to these supposed sterculiaceous forms, and whether these three families of plants may not have some common phylogenetic stock (such as the Credneriaceæ, for example), to which they may yet all be traced. This subject is one of interest only second to that of the paleontologic history of Platanus, and singularly enough both these series of forms seem to point to Credneria as a possible converging point for them all.

Pterospermites minor. n. sp.

Plate XLII, Figs. 1-3.—Burns's Ranch, Montana; two of the specimens (Figs. 1 and 3) collected by Dr. White's party in 1882.

Leaves rather thick, oblong, 3 to 4cm. wide, 5 to 8cm. long, obliquely heart shaped, more or less serrate above, entire or merely undulate below, petioled; nervation pinnate, craspedo-camptodrome; midrib straight or sinuous; lowest secondary nerves light and basilar, nearly opposite, the rest more or less ascending, alternate, branched from the under side, curving upward near their extremities and either entering the teeth or joining the tertiaries as they pass to the margin; nervilles distinct, mostly percurrent, simple and curving, sometimes forking or interlacing.

The considerable differences in these three specimens seem scarcely to justify their separation. The first one (Fig. 1) has already been men-

tioned and forms a sort of connecting link between the last and the present group. The second (Fig. 2) is shorter and broader and the teeth come farther down. This was obtained by my own party in 1883, but at the same locality. The third occupies the same slab on which one of the preceding forms (Plate XLI, Fig. 6) occurs. It has more the aspect of a Grewiopsis and is toothed to near the base; the nervation is also faintly celastroid. It is smaller than either of the others. In none of the specimens of this group, or, indeed, of all that are here referred to this genus, is the absolute summit preserved. It is strongly hoped that such specimens may yet be found in the collection, as these specimens have only been roughly selected, without the close study and comparison that remain to be given to the material.

The first specimen (Fig. 1) resembles *Pterospermites spectabilis* Heer (Fl. Foss. Arct., Vol. VII, pl. lxxxi, fig. 2) and *Pterospermum suberifolium* Willd., from the East Indies (cf. Ettingshausen, Blattsk. d. Dicotyl., pl. xlix, fig. 9), and the second (Fig. 2) may be compared to *P. ferox* Ett. (Foss. Fl. v. Wien, pl. iv, fig. 4). The third (Fig. 3), it must be confessed, resembles the other two more than it does any Pterospermum or Pterospermites that I am able to compare it with. It has, however, as already remarked, much the appearance of a Grewiopsis, and does not differ very widely from *G. tremulæfolia* Sap. (Fl. Foss. de Sézanne, pl. xxxiii, fig. 8). It also approaches Lesquereux's *Viburnum dichotomum* (Tert. Fl., pl. xxxviii, fig. 6), and still more the unfigured specimen (No. 966, already mentioned). It is also very probably the same as *Phyllites cupanioides* Newberry (Illustr., pl. xx, fig. 5), while the *P. venosus* Newberry (loc. cit., pl. xxiv, fig. 4) must probably also fall into this group.

For outlying analogues as to form and other superficial characters we may compare the specimen, Fig. 1, with *Ficus Colloti* Sap. (Monde des Plantes, p. 317, fig. 1); the specimen, Fig. 2, with *Quercus negundoides* Lx. (Tert. Fl., pl. xxi, fig. 2) and with *Rhus Evansii* Lx. (loc. cit., pl. lviii, fig. 5); and the specimen, Fig. 3, with *Ficus elegans* Web. (Palæontogr., Vol. II, pl. xix, fig. 7*a*).

CREDNERIACEÆ.

CREDNERIA Zenk.

It is unnecessary here to renew the discussion which has gone on ever since the first description of leaves of this genus by Zenker, in 1833 (Beiträge zur Naturgeschichte der Urwelt, Jena, 1833, p. 15), relative to their proper systematic position. From what has been said on the preceding page there would seem to be as yet no reason to suppose that the time has come when we can make any safe advance upon the suggestion of M. Schimper (Pal. Vég., Vol. III, p. 59) that they are more or less related to Pterospermites and Sterculia.

? Credneria daturæfolia, n. sp.

Plate XLII, Fig. 4; Plates XLIII, XLIV, and XLV.—Seven Mile Creek, Montana; white marl bed. Plate XLVI, Fig. 1, represents a leaf of *Datura Stramonium* L., introduced to illustrate the similarity of its nervation to that of the fossil leaves.

Leaves large (8 to 15cm. in diameter), thick, and coriaceous, wrinkled as if by contraction of the substance within the epidermis, roundish or ovate in outline, more or less inequilateral, provided around the border with large, unequally distant, more or less curved, sharp, spinulose teeth, often produced into long (3cm.) filliform appendages, abruptly sharp-pointed at the apex, sometimes cordate or horizontal, but usually narrowed, cuneate, or even decurrent-alate at the base; petiole nearly as long as the blade, sometimes much longer, very thick, grooved below; nervation pinnate, craspedo-camptodrome; midrib very large below, rapidly diminishing upward, somewhat zigzag and swollen at the nodes, more or less one side of the middle, often far to one side and much curved toward the smaller side; secondary nerves very variable, alternate, usually well developed, a light basilar pair sometimes present, the rest usually more or less curved upward and passing into the spinous teeth, the lower giving off strong tertiaries which generally enter the teeth, but sometimes curve and form arches along the wide entire intervals between the teeth, the upper usually simple, often curving inward near the apex of the leaf, becoming acrodrome; nervilles mostly percurrent, curved, bent or wavy, sometimes forked or broken and appearing to end blind.

A few fragments of this fossil accompanied Dr. White's collection of 1882, and my attention was strongly attracted to the peculiar indentation that some of them presented. It reminded me more of the spinulose teeth of the leaves of some species of Ilex than of those of any other leaf. The peculiar wrinkled appearance of the specimens also interested me, since it sometimes gave the impression of a very thin, rather than a thick, leathery, leaf. It was, therefore, with especial satisfaction that I found, on visiting the spot the next year under the guidance of Professor Foster, who collected the first specimens, that much better material was to be obtained. The figures represent ten of the best specimens collected by us, but a large number remain to be figured, some of which have been drawn and are before me for comparison. These furnish considerable addition to our knowledge of the plant. Its true character is masked by several circumstances. The fine wrinkles and numerous blemishes on the rock obscure the nervation so that this does not strike the eye until carefully worked out by the draftsman and shown in the drawings freed from those defects. The clay in which the leaves were embedded was filled with a great quantity of other vegetable matter that must have floated in the overlying waters: stems of various kinds, short sticks, and frequently long filiform objects that very closely imitate veins of leaves and cannot be distinguished from the spinous

processes at the ends of some of the teeth. That such processes occur there is no doubt, and one is tempted to believe that the detached filaments covering and projecting from other parts of the leaves are such appendages which belonged to nearly all the teeth and had been broken off. This view is strengthened by the fact that at points in the same bed where these leaves did not occur such loose filaments were absent.

In speculating as to the true relationship of these remarkable leaf prints and in concluding to refer them provisionally to Credneria, I am far from claiming that this disposition satisfies all the conditions of the problem and regard it as only somewhat better than calling them Phyllites. They lack almost entirely the peculiar horizontal basilar nerves, but these are not considered essential to the genus (see *C. integerrima* Zenk., Stiehler, in Palæontogr., Vol. V, pl. ix, fig. 2; *C. triacuminata* Hampe, Hos. & Mck., in Palæontogr., Vol. XXVI, pl. xxxix, fig. 156; *C. macrophylla* Heer, Kreidefl. v. Moletein, pl. iv). They are also wanting in Ettingshausenia, a genus allied to Credneria and perhaps its immediate ancestor. If we neglect this character, i. e., the lower portion of the leaf, and compare our form, Fig. 1 of Plate XLIII, with Stiehler's figure of *C. triacuminata* Hampe (Palæontogr., Vol. V, pl. x, fig. 9), we cannot but be struck with the similarity. Of course, the number of teeth in our plants is greater, teeth occurring in this same specimen to near the base, but in *C. subserrata* Hampe (loc. cit., pl. xi, fig. 10) and in *C. denticulata* Zenk. (loc. cit., pl. ix, fig. 4, and Zenker, Naturgeschichte d. Urw., pl. ii, fig. E) we have teeth at the summit not unlike those of our Figs. 2 and 3 of Plate XLIV. The leaves of most crednerias are more or less palmately triplinerved, but this is not the case with two species figured by Heer, the one from Moletein above referred to and his *C. integerrima* Zenk., from Igdlokunguak (Fl. Foss. Arct., Vol. VI, Abth. II, Kreidefl. v. Grönld., pl. xxxvi, fig. 4). In the Moletein and Greenland specimens the lower lateral nerves are disposed in very much the same general way as in ours. The smaller leaves toothed above (Pl. XLIV, Figs. 2, 3), of which more occur in the collection, resemble Ettingshausenia much more closely than they do Credneria, and may be compared with *E. cuneifolia* (Bronn) Stiehl. (in Bronn, Lethæa Geognostica, Atlas, pl. xxviii, fig. 11) and *E. tremulæfolia* (Brongn.) Stiehl. (Brongniart, Tableau des gen., p. 111; Schimper, Pal. Vég., Vol. III, p. 62, Atlas, pl. xcvi, fig. 28). The only serious objection to referring them to that genus seems to be the more simple (pinnate) nervation. But transition forms occur, as seen in Fig. 5 of the same plate and Fig. 1 of Plate LVII, which forbid the separation of any of the Yellowstone specimens.

If we look entirely outside of this group for analogues of certain characters possessed by these impressions we shall find many, but it will be difficult to find any considerable number of them combined in one species or genus. If we take the teeth, which are perhaps the most interesting feature and the one most difficult to reconcile with the

Credneria theory, we find something like them not only in our *Ilex opaca* L., but in *I. odora* Sieb. and other living species, and still more pronounced in the fossil species, *I. horrida* Sap. (Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. IV, pl. xi, fig. 9, and Vol. IX, pl. vi, fig. 3). Much the same character is also seen in forms of Hakea, figured by Saporta in the Études (*H. attenuata* R. Br., *H. mahoniæformis* Sap., op. cit., 4e Sér., Vol. XIX, pl. vii, figs. 6, 7*a*). Berberis presents other analogues, but perhaps the nearest approach is to be seen in forms of Quercus belonging to the biennial fruiting section, as, e. g., *Q. coccinea* Wang. Here there are fine spinulose filaments which are somewhat soft, at least not spiny, projecting to some distance beyond the termination of the proper lobes or teeth. In *Q. armata* Sap. (op. cit., 5e Sér., Vol. IV, pl. vi, fig. 8), we probably see an oak of this group. In *Q. grandidentata* Ung. (in Web., Palæontogr., Vol. II, pl. xviii, fig. 12) and *Q. Scillana* Gaud. (Contr., II, pl. vi, fig. 3) we see further examples of sharply toothed oaks somewhat similar to our plant.

The general form of these leaves is somewhat similar to that of some species of Platanus, such as lack the decidedly palmate nervation, as, for example, *P. Œynhausiana* Göpp. (Tert. Fl. v. Schossnitz, pl. x, figs. 1–4), and the manner in which the nerves enter the curved teeth is often imitated by *P. orientalis* L. *Cissites Heerii* Lx. (Cret. and Tert. Fl., pl. v, fig. 2) from the Dakota group is very similar to an Ettingshausenia (see figures above cited) and is vividly recalled by our smaller specimens (Pl. XLIV, Figs. 2, 3) with teeth across the summit. This comparison may prove valuable both for the Cretaceous and the Fort Union plants. Pterospermum is usually entire margined, but in *P. suberifolium* Willd. (Ett., Blattsk. Dicotyl., pl. xlix, fig.9) and in the undetermined species figured by its side (loc. cit., fig. 6) we see a tendency to lobation above that recalls Credneria and may point to some ancestor with these characters.

Without enumerating the many other forms which have presented themselves in my somewhat exhaustive attempts to match these leaves, I will conclude by referring to an unexpected analogue, the discovery of which is due to Mr. Everett Hayden, who has so successfully delineated all these specimens, in the common Jamestown-weed (*Datura Stramonium* L.). Mr. Hayden's familiarity with every detail of the nervation unconsciously led him to compare every leaf seen by him anywhere with those upon which he had bestowed so much attention, and when this came before him he was much struck by the resemblance it bears to these enigmatic fossils. He conferred with me on the subject, and I requested him to draw a leaf of the Datura to accompany his drawings of the fossils. That figure (Pl. XLVI, Fig. 1) shows how far the two forms will bear comparison and also the points of divergence. I deemed the resemblance sufficiently close to be commemorated by the specific name adopted, while at the same time I cannot say I have the least idea that it has any phylogenetic significance. The detailed nervation

(nervilles) is very unlike the fossil plant, the general form more elongate, though this varies in both the fossil and the living plants, but the general character of the secondary nerves and that of the dentation are remarkably similar in the two forms.

MENISPERMACEÆ.

COCCULUS DC.

Two of the ten species of Cocculus known to the present flora of the globe are indigenous to North America, one of which, *C. Carolinus* DC., comes as far north as Virginia. The rest belong to warmer parts of the Old World (Asia and Africa). Although this family is so unquestionably represented in a fossil state and belongs to the earliest dicotyledonous forms, it has been necessary to refer these archetypes to Menispermum or a closely allied and now extinct genus, Menispermites, or else to the problematical genus Macclintockia Heer, which its author first placed in the Proteaceæ; then, following Saporta, in the Menispermaceæ; but still later, changing his opinion again with the French author, in the Urticaceæ. If any of these types can be regarded as related to Cocculus it is this last, but its elongated form assimilates it to the Old World species, especially to *C. laurifolius* DC., and not to *C. Carolinus*.

If we except the very imperfect and questionable fragments, *C. Kanii* Sap. and *C. Dumonti* Sap., from the Heersian marls of Gelinden (Saporta, Essai, pp. 63, 65, pl. x, figs. 1, 4), no fossil Cocculus has been discovered below the Pliocene, unless we accept the view of Saporta (Vég. Foss. de Meximieux, p. 265) that many of the arctic forms referred by Heer to Populus really belong to this genus.

Cocculus Haydenianus, n. sp.

Plate XLVII, Figs. 1–4; Plate XLVIII, Fig. 1.—Burns's Ranch, Montana (Plate XLVII, Figs. 1–3). Iron Bluff, Montana (Plate XLVII, Fig. 4; Plate XLVIII, Fig. 1); one of the specimens (Plate XLVII, Fig. 4) collected by Dr. White's party in 1882. Named in honor of Mr. Everett Hayden, who has taken a special interest in this plant.

Leaves large (7 to 20cm. wide), broadly ovate or orbicular, mucronate, deeply heart shaped, entire or faintly undulate, slightly contracted above the middle, occasionally with a large rounded notch or sinus on one side near the apex or near the base or both, bounded all round by a thick marginal nerve or hem (paryphodrome); petiole long and very thick and succulent; nervation palmate or actinodrome, craspedo-camptodrome, brochiodrome; primary nerves seven to nine, rising from nearly a common point at the summit of the petiole, radiating in all directions at angles of from 30° to 50°, branching in passing out towards the borders, curving and anastomosing and forming two or three series

of loops or festoons bounded by right lines, from the outer of which short straight veinlets pass directly to the bounding nerve, each loop occupied by a somewhat radiately or concentrically arranged network of quadrate or trapeziform meshes.

The highly anomalous character of these impressions had enlisted my special interest when, in the spring of 1883, with the assistance of Mr. Everett Hayden, I made a preliminary study of the few fragments contained in Dr. White's collection of the preceding season. The nearest approach that we were able to make on that occasion was found in numerous species of Aristolochia[1] and Asarum. So vividly had the form impressed itself upon the mind of Mr. Hayden that later in the season, while I was in the Lower Yellowstone region collecting better material from the same beds, I received a letter from him, then operating with Mr. Diller's party in the Cascade Range, inclosing leaves of an Asarum (*A. Hartwegi* Watson) which he had seen growing on the mountains and thought to resemble closely the fossil leaves, as in fact they do. But after returning from that season's work with rich supplies of excellent material it soon became apparent, upon a renewal of the study of this form, that the Aristolochiaceæ did not furnish the required solution of the problem, and it was not until I had met with Saporta's figures of *Cocculus latifolius* Sap. & Mar. (Vég. Foss. de Meximieux, pl. xxxi, figs. 4–7; pl. xxxii, fig. 1) that I felt satisfied that I was at last in the way of such a solution. In these I found great solace, and the more I studied them and the genus the more satisfied I felt that the Laramie plant not only belongs to Cocculus, but to a species very closely related both to the Pliocene form and also to the living American species, *C. Carolinus* DC. In some respects our fossil forms agree better with the living plant than with that of Meximieux. For example, the marginal nerve is clearly visible in the former. This is in both cases a true hem (Saumläufer of Heer), such as we see in Callistemon and Melaleuca, and not merely a nerve running close to and parallel to the margin, as seen in many species of Eucalyptus and in *Myrica Torreyi* Lx. (Tert. Fl., p. 124, pl. xvi, figs. 4, 8), which should be distinguished by a different name. I propose to designate the truly hemming nervation by the term *paryphodrome*. Into this hem, in both the American fossil and living forms, run the short veinlets that go off from the outer loops or arches. This latter peculiarity is observable in some species of Cinnamomum, and we met with it in our *Ficus speciosissima* (*supra*, p. 39, Pl. XXI, Fig. 3), though these cases do not seem to show the bounding nerve. The presence of a distinct mucro is also a common feature of both these plants. In form, however, our fossil is nearer the Pliocene species, and the obtuse lobe seen in one of Saporta's specimens (loc. cit., pl. xxxi, fig. 5) is almost exactly reproduced in our specimen (Plate XLVII, Fig. 3).

[1] It seems to me very probable that Heer's Puilasok specimen of *Aristolochia borealis* (Fl. Foss. Arct., Vol. VII, pl. cvii, fig. 13) may represent a Cocculus very similar to ours, if not the same species.

In one of the unfigured specimens which shows scarcely anything else there occurs a still incomplete petiole over 6cm. long and of about the thickness of that of specimen Fig. 4. The petioles have the appearance of being succulent, and I can scarcely divest myself of the idea that the plant was semi-aquatic or grew in marshy districts, although this is not the habit of the living species of the genus.

This reference of these impressions to Cocculus furnishes so many evidences of being the correct one and satisfies the conditions of the question so much better than any of the other hypotheses that have at different times been acted upon that I scarcely deem it worth the reader's while to review the steps in the researches that I have made or to examine the many other forms that have been found to present some one and some another of the peculiarities that characterize this new and interesting addition to the Laramie flora.

MAGNOLIACEÆ.

LIRIODENDRON L.

Only a single species of Liriodendron, the common tulip tree of North America, remains in the present flora as the descendant of the dozen or more that have been described in the fossil state, running back to the earliest date from which we have any consistent record of the existence of dicotyledonous plants.

Liriodendron Laramiense, n. sp.

Plate XLVIII, Fig. 2.—Point of Rocks Station, Wyoming; gray sandstone bed north of station.

Leaf nearly 9cm. broad, horizontal at base, the sides vertical, entire, petioled; nervation pinnate, camptodrome, brochiodrome; midrib straight, central, rapidly diminishing upward; secondary nerves strong, straight, issuing at an angle of 60°, the lower branching dichotomously, the rest forking at some distance from the margins, forming one or two series of loops which furnish camptodrome nerves of the third and fourth order that form small areolæ close to the margin; nervilles traversing the larger areas percurrent, and straight or curved, or forking and interlacing in the middle, those within the festoons resolved into a fine network of regular quadrate or rectangular meshes.

The absence of all the upper part and much of one side of this leaf renders it impossible to say whether it possessed the characteristic lobes and truncate apex of the genus, but enough is preserved to show that if lobed the lobes are much higher up than is usual with the living species. In all the parts that are present the form and nervation are so clear and so characteristic of the genus that there seems little doubt as to its affinity. It resembles *L. Tulipifera* L. more than any of the fossil species, nearly all of which are smaller. Next after this species it should

be compared to *L. Proccacinii* Mass., which has the lobes rather high. The analogy to *Populus Stygia* Heer was mentioned in the Sixth Annual Report of the United States Geological Survey (p. 534), but the more I examine this the more I incline to regard it as accidental and superficial.

MAGNOLIA L.

This genus embraces about fourteen species, more than half of which are natives of North America, the rest occurring in eastern Asia and Japan. It is therefore just such a genus as we should expect to be represented in North American strata. We have, in fact, six Laramie species of the thirty or forty already known in the fossil state. There are seven or eight Cretaceous species, ranging from the Cenomanian to the Senonian, as many Eocene, and the remainder are Miocene. The specimens to be described are from the same bed as the one last considered. I have not succeeded in relegating them to any species thus far made known.

Magnolia pulchra, n. sp.

Plate XLVIII, Figs. 3, 4.—Point of Rocks Station, Wyoming; gray sandstone bed north of station.

Leaves broad (7 to 8cm. wide, 10 to 12cm. long), elliptical or somewhat obovate, entire, obtuse or somewhat acute short-pointed; nervation pinnate, camptodrome, somewhat brochiodrome; midrib strong throughout, nearly straight; secondary nerves proceeding from it at an angle of 50°, eight or nine on a side, subopposite or alternate, dichotomously branching once or twice, the branches anastomosing and forming arches or loops from which faint veinlets proceed towards the margin, usually appearing to lose themselves in the parenchyma; nervilles very faint, forking and joining in the middle of the areas, forming elongated cuneate areolæ.

The characters as above described are those of Magnolia. The specimen, Fig. 3, shows, with the help of a counterpart, nearly a complete leaf, except the base, which had begun rapidly to narrow. The outline is clear, black upon a gray ground, but the nervation is obscured by the presence of white blotches or dots of some material that had worked its way into the crevice made by the presence of the leaf. The other specimen is not thus affected, and shows that the nervation was somewhat hyphodrome in character, tending to prove that the leaf was rather thick, which would not otherwise appear from the specimens. The point of this latter specimen, which shows only the upper part of a smaller leaf, is quite obtuse, that of the other being acute; this, however, does not seem to constitute a specific difference.

The form seems to be nearly related to *M. Capellinii* Heer (Phyll. Crét. du Néb., pl. iii, figs. 5, 6), which, though never abruptly contracted at the summit, is sometimes obtuse, sometimes acute (compare Fl. Foss. Arct., Vol. III, Pt. II, Kreidefl., pl. xxxiii, fig. 4, with op. cit., Vol. VI,

Abth. II, Kreidefl. v. Grönland, pl. xlv, fig. 1). They also have much the same shape and character as the smaller Cretaceous species, *M. obovata* Newberry (Illustr., pl. ii, fig. 2).

GAMOPETALÆ.

EBENACEÆ.

DIOSPYROS L.

A very large genus of universal distribution, though chiefly tropical and subtropical. Of the more than one hundred and fifty species only two are North American. One of these, *D. Virginiana* L., the common Persimmon, is found throughout the Southern States and as far north as Southern New York, Ohio, and Iowa. The other, *D. Texana* Scheele, the Mexican Persimmon, is chiefly confined to Mexico and Texas.

The evidence is convincing that the genus played a prominent rôle in the floras of past geologic epochs, especially in the Tertiary, remains of its leaves, fruits, and characteristic calyx having been found in abundance. The genus ranges from the Arctic Cenomanian and American Dakota group to the upper Miocene and perhaps into the Pliocene. A large number of the species are Arctic Miocene and four are Alaskan. Of the strictly American species four are from the Dakota group, four from the Laramie group, and two from the Green River group. Two are from Vancouver Island, one from the Cretaceous of British America, and four from the Miocene of Alaska.

Diospyros brachysepala Al. Br.

DIOSPYROS BRACHYSEPALA Al. Br., Tert. Fl. v. Œningen, N. Jahrb. f. Min., 1845, p. 170. Unger, Blatterabdr. v. Swoszowice, Abh. Haidinger, III, Abth. I, p. 125, pl. xiv, fig. 15; Gen. et Spec. Pl. Foss., p. 435. Heer, Fl. Tert. Helv., Vol. III, pp. 11, 191, pl. cii, figs. 1–14; Fl. Foss. Arct., Vol. I, p. 117, pl. xv, figs. 10–12; pl. xvii, figs. 5*h*, 5*i*; Vol. II, Pt. IV (Foss. Fl. N. Greenld.), p. 475, pl. lv, fig. 8; Vol. V, Pt. II (Foss. Fl. Sibir.), p. 41, pl. xi, figs. 3–6*a*; Vol. VI, Abth. I, Pt. II (Nachtr. z. Foss. Fl. Grönld.), p. 13, pl. iii, figs. 15, 16; Vol. VII, p. 109, pl. lxxix, figs. 1–8; pl. xcii, fig. 10; pl. xciv, fig. 6; Mioc. Balt. Fl., p. 84, pl. xxvii, figs. 1–6; pl. xxviii, fig. 1; Braunkohlenpfl. v. Bornstädt, p. 16, pl. iii, figs. 7, 8; Urw. der Schweiz, pp. 354, 355, fig. 215. Sismonda, Pal. Terr. Tert. du Piém., p. 443, pl. xi, fig. 6; pl. xvi, fig. 5; pl. xix, fig. 3. Ettingshausen, Foss. Fl. v. Bilin, II (Denkschr. Wien. Acad., Vol. XXVIII), p. 232, pl. xxxviii, fig. 28; pl. xxxix, fig. 1; Foss. Fl. d. Wetterau (Sitzb. Wien. Acad., Vol. LVII, Abth. I), p. 865, pl. iii, fig. 7. Engelhardt, Fl. d. Braunk. Sachsen (Preisschr. Jabl. Ges., 1870, XVI), p. 21, pl. v, figs. 8–10; Tert. Fl. v. Göhren (Nova Acta L.-C. Acad., Vol. XXXVI), p. 28, pl. (v) xii, fig. 7; Tert. Pfl. Leitmeritz (op. cit., Vol. XXXVIII), p. 362, pl. xviii, figs. 1, 2. Lesquereux, Tert. Fl., p. 232, pl. xl, figs. 7–10; pl. lxiii, fig. 6; Cret. and Tert. Fl., p. 174, pl. xxxiv, figs. 1, 2. Schimper, Pal. Vég., Vol. II, p. 949. Geyler, Foss. Pfl. a. d. Obertert. Ablag. Sicilien's, p. 326, pl. (i) lxviii, figs. 12, 13. Zwanziger, Mioc. Fl. v. Liescha, p. 66, pl. xxv, figs. 1, 2. Pilar, Fl. Foss. Susedana, p. 82, pl. xiv, fig. 1.

Plate XLIX, Figs. 1, 2.—Burns's Ranch, Montana (Fig. 1). Seven Mile Creek, Montana (Fig. 2).

The nearly perpendicular nervilles and the slightly decurrent base are about the only objections to this reference. The first of these may be seen in many of the figures that have been assigned to this species, while the latter is clearly visible in two of Heer's figures (Fl. Tert. Helv., pl. cii, figs. 4, 7). I therefore refer these two impressions to that widespread and polymorphous species with considerable confidence.

Diospyros ficoidea Lx.

DIOSPYROS ? FICOIDEA LX., Bulletin U. S. Geol. Surv. Terr., Vol. I, p. 387; Ann. Rep. U. S. Geol. Surv. Terr., 1874, p. 314; Tert. Fl., p. 231, pl. xl, figs. 5, 5*a*, 6.

Plate XLIX, Figs. 3, 4.—Burns's Ranch, Montana (Fig. 3). Clear Creek, Montana (Fig 4).

The close correspondence between these specimens and those from Black Buttes collected by Mr. F. B. Meek leaves little room for doubting their specific identity. There is one unfigured specimen (No. 336 Nat. Mus., Lesquereux's original No. 862) which shows the base and petiole. It is smaller than our specimen, Fig. 4, but agrees substantially with it in the form of the base. The petiole is here shown to be 1.5cm. long and somewhat curved. This specimen should be figured. The Clear Creek specimen occurs in immediate association with the abundant Viburnum leaves. In the Burns's Ranch specimen we have the oblique nervilles, nearly perpendicular to the midrib, slightly curving first upward and then downward, in strict imitation of those of *D. Virginiana* L. The ultimate nervation in both specimens is very similar to that figured by Lesquereux from the Black Buttes specimens (loc. cit., fig. 5*a*).

? Diospyros obtusata, n. sp.

Plate XLIX, Fig. 5.—Seven Mile Creek, Montana; bed below the ironstone.

Leaf thick, coriaceous, ovate, 4.2cm. wide, 7cm. long, entire, rounded at the base, obliquely obtuse at the summit; nervation pinnate, camptodrome; midrib strong, nearly straight, central; secondary nerves eight on a side, inequidistant, issuing at an angle of 40°, branching above, curving upward and forming single or double rows of arches, lower ones opposite, lowest pair light basilar, simple, third and fourth pair strongest, uppermost curving inward; nervilles rather indistinct, simple, straight or slightly curved, percurrent, somewhat oblique to the nerves they join.

This specimen seems to represent a hitherto undescribed species of Diospyros. Its nearest affinities are perhaps with *D. varians* Sap. (cf. Études, Ann. Sci. Nat., Bot., 5e Sér., Vol. III, pl. vi, fig. 4A), which, however, is usually much more elongated and often acute at the base. In general form and principal nervation it approaches the *Phyllites ovatus* of Rossmässler (Verstein., pl. ii, fig. 9) more closely than any other figure with which I have been able to compare it, but in that the

secondary nerves are all alternate and the finer details are obscure, especially around the margin. That figure may represent a Diospyros, though no author has, to my knowledge, ever thus referred it.

Our form is not unlike certain leaflets of the Leguminosæ and may be compared to *Dalbergia grandifolia* Sap. (op. cit., Vol. IV, pl. xiii, fig. 13) or to *Leptolobium tomentosum* Pohl (Ettingshausen, Nervation d. Papilionaceen, Sitzb. Wien. Acad., Vol. XII, pl. xviii, figs. 3, 4).

CAPRIFOLIACEÆ.

VIBURNUM L.

The important rôle which this genus has played in the fossil flora of the globe is the more remarkable as it is always assigned to the gamopetalous division of dicotyledonous plants, otherwise so rare in the fossil state. But this need not perhaps surprise us when we remember that so far as known all the species of Viburnum are shrubby and that they grow chiefly in low ground along the banks of streams and bodies of water, where their leaves have an excellent opportunity to be embedded in the mud of river deltas and inland seas. The classification according to the presence or absence of petals or their freedom or cohesion is no longer believed to have any great phylogenetic value, and the chief reason for believing that the Gamopetalæ were the last to appear is the fact that in the present flora a so much larger proportion of them are herbaceous than of the other divisions of Dicotyledons. This fact, too, supposing it to have always been so, would account for the small number found fossil, since it is very difficult for herbs to be preserved. But it is not believed that it has always been so, for nearly all the fossil floras bear evidence of a warmer climate, and the effect of a warm climate is to convert the herbs into shrubs and trees. Again, this condition of the floral envelopes has manifestly been subject to alteration through geologic periods, and it by no means follows that because a form is now gamopetalous or polypetalous it was so in Miocene or Eocene time, and the discovery of the flowers themselves in sufficiently perfect condition to test this question is an event that rarely, one may almost say never, happens.

That Viburnum is a very ancient type there is much evidence. It now embraces about eighty species and is distributed throughout all the temperate and subtemperate regions of the northern hemisphere. It is also found on the Andes. Fourteen species are indigenous to North America, nearly all of which are abundant. About forty species are known in the fossil state, among which the two now living species, *V. Tinus* L. and *V. pubescens* Pursh, are thought to be identified. They range from the upper Cretaceous of Greenland (Patoot) and Westphalia to the Pliocene of Meximieux and the Canary Islands. Thus far none have been reported from the Cenomanian or Dakota group and none

from the Green River group. Aside from the Miocene, which, of course, furnishes a great number, the Laramie group seems to be the richest of all the formations in plants of this type, no less than fifteen species having been already reported from its several beds in the west. Seven of these come from the upper or Fort Union deposits, and it is from these latter that all the additions that I have to make are also derived. In the several beds on the Lower Yellowstone visited by Dr. White in 1882 and by myself in 1883, and notably those of Clear Creek and Cracker Box Creek on the left bank of the river, there was found a vast profusion of Viburnum leaves and numerous seeds referable with great certainty to that genus. The study of these impressions, which was still unfinished when my paper for the Sixth Annual Report went to press, had then revealed the presence in those collections of much greater variety in these forms than I had believed when engaged in collecting them, and I was obliged to regard as distinct species no less than fourteen of the forms referable to that genus, ten of which must be provisionally treated as new to science.

Viburnum tilioides.

TILIA ANTIQUA Newberry, Later Extinct Floras, pp. 30, 52; Illustr., pl. xvi, figs. 1, 2. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1876, p. 514; Cret. and Tert. Fl., p. 233. Schimper, Pal. Vég., Vol. III, p. 115.

Plate L, Figs. 1-3; Plate LI, Figs. 1-8; Plate LII, Figs. 1, 2.—Clear Creek, Montana; one of the specimens (Plate LII, Fig. 2) collected by Dr. White's party in 1882.

Leaves thickish, ovate or elliptical, 6 to 12cm. wide, 7 to 14cm. long, heart shaped, short-pointed, rather coarsely and regularly simply toothed to very near the base; nervation pinnate, craspedodrome, very prominent, forming deep furrows or ridges upon the stone; midrib nearly straight, generally central, but sometimes far to one side; secondary nerves about nine on each side, the lower approximate or wedging together near the base of the leaf, sometimes nearly opposite and horizontal, the rest more distant and ascending, all but the upper branching somewhat sympodially from the under side, the upper strictly once or twice forked near their extremities; tertiary nerves usually entering the teeth; nervilles very distinct, usually simple, straight, approximate, parallel, percurrent, traversing the areas at right angles to the nerves, sometimes curved or wavy, rarely forked or united, branches from the outer ones sometimes entering the sinuses of the margin; drupes 2 to 2.5cm. long, 1cm. thick, short pediceled; putamen deeply 2 to 3 grooved longitudinally.

The eight leaf specimens here brought together differ considerably from one another, more perhaps than would be found to be the case with as many leaves of the same species of a living plant, even though taken at random from different trees and from different parts of the trees. Yet any one who has made a practice of comparing leaves in this way from known species is prepared to expect a wide variation in almost

any class of plants. At the same time, after a renewed study of these forms, I am ready to eliminate the specimens, Figs. 1, 2, Plate LI, and Fig. 1, Plate LII, and refer them to other species. The rest, notwithstanding the variety observed, seem with scarcely any doubt to belong to one and the same species.

The above description, as any one may see, will include all the characters of *Tilia antiqua* Newberry, and there is no assignable difference between the only specimen I have seen of that species, which is one of those figured in the Illustrations of his Later Extinct Floras (pl. xvi, fig. 2), and several of those collected by myself (cf. Figs. 1, 3, Pl. L; Fig. 3, Pl. LI). In two of the specimens (Fig. 2, Pl. L, and Fig. 2, Pl. LII) the only noteworthy difference is that these are quite obviously inequilateral; but, as Dr. Newberry states that his plant is "often somewhat unsymmetrical," it may be inferred that he has specimens of a similar character.

The question of the identity of the plants described under these two names may then be regarded as settled, and it remains to justify the reference of them all to Viburnum rather than to Tilia. Messrs. Bentham and Hooker, in their Genera Plantarum, admit only eight species of Tilia as known to the living flora, although ten are described in De Candolle's Prodromus. I have carefully examined specimens referred by their labels to sixteen different species, several of them, of course, merely synonyms, but differing somewhat, and I believe these to embrace nearly all the forms known. I find them all to agree in possessing a strictly palmate nervation. The bundles of the petiole divide at the very base of the blade into a number (five to seven), often an even number, of primary nerves, one of which is always somewhat larger than the rest, but not analogous to the midrib of a penninerved leaf. The first true secondary nerves rise from the midrib, usually nearly opposite, at a considerable distance above the common origin of the lateral primaries. In this important respect the Fort Union leaves do not agree with Tilia. They are strictly penninerved leaves. The lowest secondaries arise from above the base of the blade. They do not all arise from precisely the same point, but are somewhat alternate. The next succeeding secondary nerves are not distant from these, but are nearer to them than to the ones above them. These are not characters of Tilia. All other authors have respected these facts, and of the great number of alleged fossil linden leaves which have been figured I find only one or two cases in which they have been disregarded, as, for example, Ettingshausen's *T. Milleri* (Tert. Fl. Steiermark's, Sitzb. Wien. Acad., Vol. LX, Abth. I, pl. v, fig. 2) and one of Heer's Spitzbergen specimens of *T. Malmgreni* (Fl. Foss. Arct., Vol. IV, Pt. I, Spitzb., pl. xix, fig. 18), and these I would incline to exclude from the genus.

When, however, we turn to Viburnum and look in the section Lantana we find nearly all these conditions satisfied. We find ovate, dentate, penninerved leaves, the lower nerves more approximate than the upper,

and somewhat wedging in together at the base, branching below and becoming dichotomous above. And if we are not satisfied with the size and amplitude of *V. Lantana* L., which, however, sometimes has leaves of considerable size (cf. Ettingshausen, Blattsk. d. Dicotyl., pl. xx, fig. 12), we have only to turn to our indigenous *V. lantanoides* Michx., the hobble-bush or wayfaring-bush, which inhabits the moist woods of the northern parts of the United States and of Canada and the mountains of more southern districts, and we here find a leaf having almost exactly the size, shape, and nervation of the fossils figured by Dr. Newberry, the resemblance being nearer to these than to any of the specimens collected by myself. The teeth only are a little less prominent, those of *V. Lantana* approaching more nearly those of the fossil form. With Dr. Newberry's willingness to find living species among fossil remains, the wonder is not so much that he should have referred these forms to Tilia as that he did not declare them merely a fossil state of *V. lantanoides*.

Finally, in addition to this evidence, I find in the beds where these leaves are so abundant as to obscure the presence of all other kinds a large number of detached fruits having all the characteristics of the drupes of Viburnum, but as large as those of the section Lentago, the black-haw or sheep-berry. Unlike these latter, however, yet agreeing in this respect with the section Lantana, the stone of these fruits is distinctly grooved or fluted. They are similar to Heer's *V. macrospermum* (Fl. Foss. Arct., Vol. II, Pt. III, Spitzb., pl. xiii, figs. 24–28). In some (Pl. LI, Figs. 6, 8) the stone alone seems to have been preserved. In others (Figs. 5, 7) the softer portions have left their impression. As several of the species still to be described were also found in this bed it is not certain, of course, that some or all of these fruits may not have belonged to one or more of these; yet, in view of the much greater abundance of this form, it seems more safe to refer the seeds to this species, and as no good characters have yet been found on which to separate them it seems that they must all go together. Still it is quite probable that some of them may belong to other species.

The size of these seeds would alone be sufficient to separate them specifically from both *V. Lantana*, which has seeds scarcely more than a centimeter long, and from *V. lantanoides*, which has them considerably less than a centimeter in length, and, therefore, we may treat both leaves and seeds as constituting an extinct species and commemorate the analogy of the former with the genus Tilia by giving the species a name derived from that genus.

Viburnum perfectum, n. sp.

Plate LII, Figs. 3, 4; Plate LIII, Fig. 1.—Clear Creek, Montana.

Leaves elliptical, provided with a long slender petiole which is more or less bent, curved, or hooked at its proximal extremity; otherwise as in the last, of which it is probably merely a form.

I am, on further study, fully satisfied that these specimens do not constitute a species distinct from the one last described. It was a peculiarity of these Viburnum leaves at Clear Creek that they were nearly all without petioles, so much so that for a long time I was inclined to doubt whether they ever possessed them. But finally a very few specimens were found with petioles, and one (Plate LII, Fig. 4) with a very long one, curiously, and doubtless accidentally, bent below. I know of no living Viburnum that has a petiole of any such length. In the specimen, Fig. 3, Plate LII, the petiole is probably nearly complete and much shorter, hooked near the point of attachment. The specimen Fig. 1, Plate LIII, should evidently have been grouped with Fig. 3, Plate LI, and it is open to doubt whether it was narrowed or heart shaped at the base, though the way in which the lowèst pair of nerves issue from the midrib indicate the former, and Mr. Hayden has thus restored it.

Viburnum macrodontum, n. sp.

Plate LIII, Fig. 2.—Clear Creek, Montana.

Leaves elliptical, sharp-pointed, provided with large and long unequal teeth above; otherwise as in the last two species.

A number of fragments occur in the collection from Clear Creek with large prominent teeth, though differing in no other respect, so far as the specimens indicate, from the other large Viburnum leaves. I am inclined to think that if we had perfect specimens it would be found that these represent a distinct species. The teeth are similar to those of *V. Dentoni* Lx. (Cret. and Tert. Fl., pl. xlix, figs. 2, 3), but less sharp, and the other characters are different. That plant is from the "Bad Lands of Dakota," and is probably a near ally of the Clear Creek species.

Viburnum limpidum, n. sp.

Plate LIII, Figs. 3–6.—Clear Creek, Montana.

Leaves small (4 to 6cm. wide, 5 to 8cm. long), petioled, round-ovate or somewhat obovate; nervation as in the preceding species.

If it were a question of size alone I should hesitate to separate these forms from those previously described, when the nervation is so nearly identical. I have observed differences in *V. Lantana* of from 5 to 10cm. in length of leaf, but it is fair to say that the smaller ones accompanied flowering specimens and may have been immature. Such leaves do not fall off, and therefore would not occur in a fossil state. I have never observed such differences in *V. lantanoides*. In the present case, however, the shape is somewhat different. The leaves are truncate or narrowed, not heart shaped, at the base, and tend to be obovate. The first specimen (Fig. 3), which is the smallest, is more ovate, and the nervation is more lax and erect. It may be distinct from all the others. It closely resembles Ettingshausen's *Tilia Milleri* (Tert. Fl. Steiermark's, Sitzb. Wien. Acad., Vol. LX, Abth. I, pl. v, fig. 2), to which reference

has already been made. The other three are very homogeneous and clearly belong together. They form a transition to the next species, which probably belongs to another section of the genus.

Viburnum Whymperi Heer.

VIBURNUM WHYMPERI Heer, Fl. Foss. Arct., Vol. II, Pt .III (Mioc. Fl. Spitzbergens), p. 60, pl. xiii, figs. 3*a*, 4, 5; Pt. V (Foss. Fl. N. Greenland), p. 475, pl. xlvi, fig. 1*b*; Vol. VII, pl. cii, fig. 13*a*. Lesquereux, Ann. Rep. U. S. Geol. Surv. Terr., 1872, p. 395; 1874, p. 306; Tert. Fl., p. 225, pl. xxxviii, fig. 7; pl. lxi, fig. 23. Schimper, Pal. Vég., Vol. II, p. 885.

Plate LIV, Fig. 1.—Clear Creek, Montana.

The agreement with Heer's figure of the Greenland leaf is very close, and I have before me leaves of *V. dentatum* L. which, for both size and form, might almost have served as the original of the drawing. Heer's figure of the fruits from Spitzbergen, however, show no grooves, which puts them into another section, perhaps with *V. pubescens* Pursh.

Viburnum perplexum, n. sp.

Plate LIV, Figs. 2, 3.—Burns's Ranch, Montana; collected by Dr. White's party in 1882.

Leaves rather small (5cm. wide), unsymmetrical, obliquely ovate, truncate at base, blunt-pointed, somewhat regularly and coarsely simply serrate, petioled; midrib eccentric, curved, sinuous, or zigzag; secondary nerves erect at their insertion, rising and curving outward, the upper ones more or less sinuous; otherwise as in the preceding species.

It was with considerable doubt that I placed these two forms together, and the second one (Fig. 3) is very probably an irregular form of *V. Whymperi* Heer. The other (Fig. 2) is very anomalous in form and somewhat so in nervation, yet seems to conform vaguely to the one general type to which all the above specimens belong. In a general way it recalls several figures of more or less problematical character scattered through the books (cf. *Tilia Saviana* Mass., Fl. Foss. del Senigal., pl. xxxix, fig. 9; *Phyllites De-Visianii* Sism., Pal. Terr. Tert. du Piém., pl. xxx, fig. 6; *Betula Sezannensis* Sap., Fl. Foss. de Sézanne, pl. xxxvi, fig. 10), but agrees with none in its essential characters. It is almost certainly one of the Viburnums, but whether a mere sport or the representative of a distinct species the one specimen we possess, notwithstanding that this is admirably preserved, cannot make us certain. It has a certain general resemblance to the specimens from the same bed that I have called *Ficus viburnifolia* (*supra*, p. 42, Pl. XXII, Figs. 4–8), and putting the characters of both these forms together they embody most of those of *Phyllites carneosus* Newberry (Later Extinct Floras, p. 75; Illustr., pl. xxvi, figs. 1, 2), which may represent an archaic Viburnum.

Viburnum elongatum, n. sp.

Plate LIV, Figs. 4, 5.—Clear Creek, Montana.

Leaves elliptical-lanceolate, 5 to 6cm. wide, 10 to 12cm. long, rounded or truncate at the base; somewhat irregularly obtuse-dentate to very near the base; midrib curved, slightly zigzag; secondary nerves all ascending; otherwise as in *V. tilioides*.

A large number of these elongated leaves occur in the collection, and they agree substantially without presenting transition forms to the other species already described. I therefore regard them as constituting a distinct species. I incline to believe that this is the same plant that Dr. Newberry described in his Later Extinct Floras (p. 75) and figured (Illustr., pl. xxvi, figs. 3, 4) as *Phyllites venosus*, though the widest part is here a little higher.

Viburnum oppositinerve, n. sp.

Plate LV, Figs. 1, 2.—Clear Creek, Montana.

Leaves small (2.5 to 3cm. wide, 5 to 6cm. long), ovate or ovate-lanceolate, sharp-pointed, narrowed, or rounded at the base, oblique or one-sided, toothed all round; midrib curved; some of the principal lateral nerves opposite or subopposite, rising at a wide angle and immediately curving upward. Otherwise as in *V. tilioides*.

This species has a very close resemblance to *V. pubescens* Pursh, a native of North America. The two specimens do not exactly agree in dentation and one is considerably more elongate than the other, but I do not feel justified in separating them on these grounds. The teeth are too coarse and the lower secondaries too light for *V. lanceolatum* Newberry (Illustr., pl. xvi, fig. 10); the analogy is closer, except as to size, with *V. Dakotense* Lx. (Cret. and Tert. Fl., pl. xlviA, fig. 9), especially as regards the first specimen (Fig. 1).

Viburnum erectum, n. sp.

Plate LV, Fig. 3.—Clear Creek, Montana.

Leaf lanceolate, long and sharp-pointed, toothed above; secondary nerves very erect, some of the upper ones curving inwards to join the branches of the next higher, the short tertiary nerves from the angled arches thus formed passing into the teeth; nervilles approximate, parallel, mostly percurrent, generally somewhat curved or bent in the middle, traversing the areas at right angles to the nerves.

It must be freely confessed that this specimen is too imperfect to found a species upon, and if better material is ever found it may be either confirmed or rejected. But several of the characters that appear in this fragment are not seen in any of the other specimens. The slightly celastroid tendency of the nervation, also faintly seen in one of the specimens of the last species (Fig. 2), is thus far new to this group, and may have some special significance. Aside from this there are many rea-

sons for uniting it with the larger species from Cracker Box Creek (cf. Plate LVI, Figs. 1, 5, and 6)

Viburnum asperum Newberry.

VIBURNUM ASPERUM Newberry, Later Extinct Floras, pp. 31, 54; Illustr., pl. xvi, figs. 8 (9?). Schimper, Pal. Vég., Vol. II, p. 884. Lesquereux, Cret. and Tert. Fl., p. 230.

Plate LV, Figs. 4–9.—Cracker Box Creek, Montana (Figs. 4–8). Seven Mile Creek, Montana; Sparganium bed (Fig. 9).

I am now disposed to regard the specimen from Seven Mile Creek (Fig. 9) as distinct from the others. It should, perhaps, be classed with one from Clear Creek above described (Fig. 1 of the same plate). It may also be compared with *V. lanceolatum* Newberry (loc. cit., fig. 10).

I can scarcely persuade myself that Newberry's *Rhamnites concinnus* loc. cit., fig. 7) is anything but a very regular and symmetrical form of this plant with the upper secondary nerves nearly simple.

Viburnum Newberrianum, n. sp.

Plate LVI, Figs. 1–6.—Cracker Box Creek, Montana.

Leaves ovate or ovate-lanceolate, slightly heart shaped, acuminate, more or less regularly and rather finely and sharply simply serrate to the base, 3 to 6 cm. wide, 6 to 12 cm. long, exclusive of the long (4 to 5 cm.) petiole, which is thickened and grooved below; nervation subpalmate, craspedodrome; midrib strong, usually straight; lateral nerves all, or all but a very light basilar pair, branching freely from the under side, the upper ones forking, lower ones opposite, second or third pair much stronger than the rest, ascending at an angle of 30° to 35°, carrying six to nine strong, branched or forking secondaries, slightly curving upward and reaching the margins far above the middle; branches from the midrib alternate, rising at angles successively more acute, the uppermost becoming nearly vertical, the lowest remote from the principal lateral nerves; nervilles rather faint, nearly all simple and percurrent, traversing the areas somewhat obliquely and nearly at right angles to the midrib, sometimes curved, bent, or forking.

This species, although from the same beds and much resembling it otherwise, is clearly distinguished from the preceding by its compound (subpalmate) nervation, that of *V. asperum* being always simply pinnate. In this respect it also differs from all the non-lobate Viburnums with which I am acquainted and approaches more closely to Ceanothus. In *C. Americanus* L., the common North American species, however, the leaf is decidedly triplinerved, the lateral primaries somewhat acrodrome and having their origin at the very base or even running for some distance below the blade and inclosing a little parenchymatous tissue between them and the petiole. But there is a Mexican species (*C. azureus* Desf.) which has these characters much less marked and closely approaches these fossil leaves in this respect as well as in general shape

(cf. Ettingshausen, Blattsk. d. Dicotyl., pl. lxix, fig. 16). There is, however, in our specimens a peculiar dichotomy and definite symmetry which are characteristic of Viburnum and not of Ceanothus, and, until fruits or other convincing proofs are found, they may be left where they are. It seems at least certain that any change must affect *V. asperum* as well as the present species.

In naming this very handsome species I have wished to do honor to a pioneer in the work of bringing to light the floral treasures hidden in the Fort Union strata, where these specimens were found, and by the light of whose researches my own investigations have been so largely guided.

Viburnum Nordenskiöldi Heer.

VIBURNUM NORDENSKIÖLDI Heer, Fl. Foss. Arct., Vol. II, Pt. II (Fl. Foss. Alask.), p. 36, pl. iii, fig. 13; Vol. IV, Pt. I (Foss. Fl. Spitzb.), p. 77, pl. xv, fig. 5a; pl. xviii, fig. 7; pl. xxiii, fig. 4b; pl. xxix, fig. 5; Vol. V, Pt. I (Mioc. Fl. Grinnell-Land.), p. 36, pl. iv, fig. 4d; pl. vii, figs. 5–7; Vol. VI, Abth. I, Pt. III (Mioc. Fl. N. Can.), p. 15, pl. i, fig. 8; Vol. VII, p. 115, pl. xcii, fig. 11; pl. xcvi, fig. 2. Schimper, Pal. Vég., Vol. II, p. 885. Lesquereux, Cret. and Tert. Fl., p. 230, pl. xlviA, figs. 6, 7.

Plate LVII, Figs. 1–3.—Clear Creek, Montana (Fig. 1). Little Missouri River, Dakota (Fig. 3). Gladstone, Dakota (Fig. 2). The last two were collected by Dr. A. C. Peale in 1883.

It is altogether probable that these specimens belong to the same plant as Lesquereux's specimen fig. 7, but there is much doubt in my mind as to the identity of that specimen with those of the north. Heer's figures all show a degree of irregularity and indefiniteness which does not comport with the forms from Dakota and Montana. The Gladstone specimen deviates somewhat from the other two in that the principal pair of lateral nerves rise nearer the base and keep nearer the margin, allying it with *V. asperum*, while the str g branching lower nerves and erect lateral subprimaries of the Clear Creek and Little Missouri specimens ally them rather with *V. Newberrianum*. They all bear, moreover, a certain resemblance to the forms which I have referred to Grewia (*G. celastroides*, supra, p. 86, Pl. XXXIX, Fig. 2, and *G. Pealei*, p. 87, Pl. XXXIX, Figs. 3–5); and in one of the specimens (Fig. 1) traces of the peculiar marginal nervation of that group are visible. In lacking the dichotomous branching of the Viburnum group these forms are even more assimilated to Ceanothus than the ones last considered. Their reference to this species is therefore, on the whole, of very doubtful propriety.

Viburnum betulæfolium, n. sp.

Plate LVII, Fig. 4.—Burns's Ranch, Montana; collected by Dr. White's party in 1882.

Leaf thick, coriaceous, broadly ovate, short-pointed, 4.2cm. wide and but little longer, coarsely and irregularly toothed; nervation pinnate craspedodrome; midrib straight, nearly central; secondary nerves rising at a large angle (50° to 60°), sometimes branching dichotomously from near their origin, once to thrice forking towards their extremities,

the ultimate ramifications entering the blunt teeth; nervilles straight, generally simple, percurrent, crossing the intervals at right angles to the nerves, sometimes forking in the middle.

The base is wanting and its form cannot be safely divined. The leaf differs from all others in the collection that I have thus far studied, and also from any living or fossil leaf known to me, but it seems to have many of the characteristics of a Viburnum. Its nearest analogue from a superficial point of view seems to be one of Heer's Sachalin specimens of *Betula prisca* Ett. (Fl. Foss. Arct., Vol. V, Pt. III, Prim. Fl. Foss. Sachal., pl. v, fig. 9), which, however, is much smaller, and in the other large figure (fig. 10) the form is different. It also resembles somewhat in form *Betula Blancheti* Heer (Fl. Tert. Helv., pl. lxxi, fig. 26), but the teeth are less sharp and the lateral nerves less straight and regular, besides being forked. It also vaguely simulates some leaves of Cratægus.

Viburnum finale, n. sp.

Plate LVII, Fig. 5.—Iron Bluff, Montana.

Leaf rather thin, ovate-lanceolate, somewhat falcate, 5cm. wide, 10cm. long, rounded and oblique at the base, pointed at the summit, finely and sharply serrate; nervation pinnate, craspedodrome; midrib very thick, rapidly diminishing above the middle, regularly curved, slightly eccentric; secondary nerves relatively slender, nearly uniform and parallel, about fourteen on each side, the lower branching from the under side, the branches forking near the margin, the rest once to thrice forked, the ultimate ramifications entering the teeth; nervilles faint, percurrent, parallel, crossing the spaces at nearly right angles to the secondary nerves.

Notwithstanding the dichotomous viburnoid nervation of this leaf, I find it difficult to believe that it is not after all a member of the group of forms found at Iron Bluff and Burns's Ranch, most of which I have referred to the Celastrineæ. They seem to possess the characters of that family in varying degrees and to diverge in several directions towards other classes of plants. One I was reluctantly compelled to single out and refer to Juglans, and this one has found its way into the group of Viburnums. Those which I have called *Celastrus alnifolius* I was strongly tempted to treat as forms of Alnus, and the species last described may belong to Betula. Yet they all seem to me to be related. This feeling, however, may be partly due to local association, and there is certainly nothing strange in finding so many different families of plants represented at one spot, since that is what we actually find in the present flora. Although we here have the outline of the leaf very well shown, the finer details of the nervation are obscured, especially along the margins, and it is possible that if more could be made out the characteristic features of the group with which it was associated might be found to belong in some degree to this specimen.

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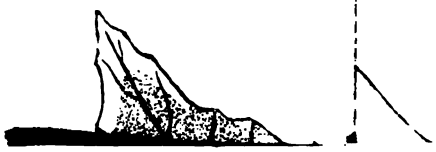

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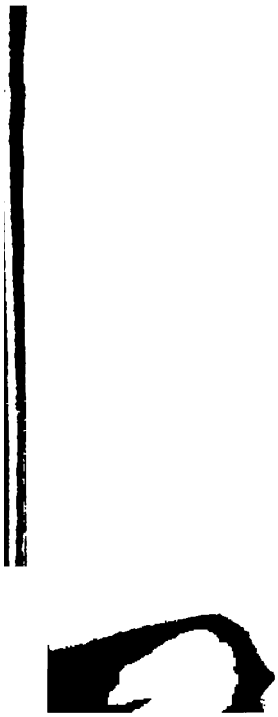

U. S. GEO

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[Genera and all higher groups are printed in SMALL CAPITALS; synonyms in *italics*. Heavy-faced figures refer to pages on which descriptions are given.]

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